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ABSTRACT

This self-paced student training module on carpentry materials is part of the course, Carpentry Trade, which was developed for Preapprenticeship Phase 1 Training. (A companion instructor's guide is available separately as CE 032 875.) The course is designed to provide students with an orientation to the trade and an opportunity to explore it. The purpose of the module is to teach students to identify and explain use of commonly used building materials, including selection, use, and grades of lumber and sheet material. The module may contain some or all of the following: a cover sheet listing module title, goal, and performance indicator; study guide/checklist with directions for module completion; introduction; information sheets providing information and graphics covering the module topic(s); supplementary references; self-assessment; self-assessment answers; post assessment; and post-assessment answers. (YLB)

INDIVIDUALIZED LEARNING SYSTEMS

PRE-APPRENTICESHIP PHASE 1 TRAINING

CARPENTRY MATERIALS

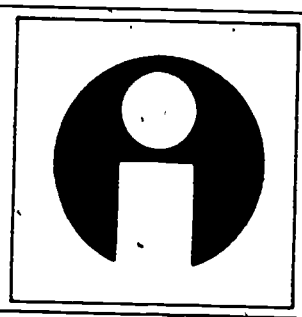
Goal:

The student will be able to identify and explain the use of commonly-used building materials, including selection, use and grades of lumber and sheet material.

Performance Indicators:

The student will demonstrate knowledge of the material by successfully completing a Self Assessment and a Post Assessment exam.

Study Guide



Complete the following tasks in order to successfully complete the module. Check each task off as you complete it.

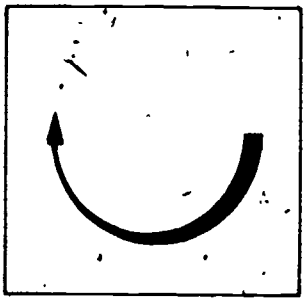
1. ____ Read the Goal and Performance Indicators on the cover of this module.

2. ____ Study the Information section. This will give you the knowledge necessary to pass the exams.

3. ____ Complete the Self Assessment exam and compare your answers with those on the Self Assessment Answer Sheet. If you had trouble on the Self Assessment, re-study the Information section before continuing.

4. ____ Complete the Post Assessment exam, and turn your answers in to your instructor.

Information



Lumber is the designation given to produces of the sawmill and includes: boards used for flooring, sheathing, paneling, and trim; dimension lumber used for sills, plates, studs, rafters and other framing members; timbers used for posts, beams and heavy stringers; and numerous specialty items.

The carpenter must have a good working knowledge of lumber--kinds, grades, sizes and other aspects that apply to its selection and use.

KINDS OF WOOD

Lumber may be classified as either softwood or hardwood. Softwood comes from the evergreen or needle bearing trees. These are called "conifers" because many of them bear cones. Hardwood comes from broadleaf (deciduous) trees that shed their leaves at the end of the growing season. This classification is somewhat confusing, however, because many of the hardwood trees produce a softer wood than some of the so-called softwood trees.

Several of the more common kinds of commercial softwoods and hardwoods are:

Softwoods	Hardwoods
Douglas Fir	Brasswood
Southern Pine	Willow
Western Larch	American Elm
Hemlock	*Mahogany
White Fir	Sweet Gum
Spruce	*White Ash
Ponderosa Pine	Beech
Western Red Cedar	Birch
Redwood	Cherry
Cypress	Maple
White Pine	*Oak
Sugar Pine	*Walnut

*Open grained wood

A number of hardwoods have large pores in the cellular structure (called open grain woods) and require special or additional operations in the finishing procedure.

In addition to hardness and softness, different kinds of wood will vary in weight, strength, workability, color, texture, grain pattern and odor. Several of the softwoods used in construction work are similar in appearance and considerable experience is required to make identification accurately and quickly.

Availability of different species (kinds) of lumber varies somewhat throughout the country. This is especially true of framing lumber which is expensive to transport over long distances. It is usually more economical to select building materials (lumber, stone, etc.) that reflect the natural resources of the area.

CUTTING METHODS

Most lumber is cut in such a way that the annular rings form an angle of less than 45 degrees with the surface of the board. This method produces lumber that is called Flat-Grained if it is softwood, or Plain-Sawed if it is hardwood. Minimum waste is incurred in using this method and desirable grain patterns are obtained.

Lumber can also be cut so the annular rings form an angle of more than 45 degrees with the surface of the board. This method produces lumber that is called Edge-Grain if it is softwood, and Quarter-Sawed if it is hardwood. It is more difficult and expensive to use this method but it does produce lumber that swells and shrinks less in width and is not so likely to warp.

MOISTURE CONTENT AND SHRINKAGE

Before wood can be used commercially, a large part of the moisture (sap) must be removed. When a living tree is cut, more than half of its weight may be moisture. Lumber used for framing and outside finish should be dried to a moisture content of about 15 percent. Most cabinet and furniture woods are dried to a moisture content of 7 to 10 percent.

The amount of moisture or moisture content (M.C.) in wood is expressed as a percent of the oven-dry weight. To determine the moisture content, a sample is first weighed. It is then placed in an oven and dried at a temperature of about 212 degrees F. The drying is continued until it no longer loses weight. The sample is weighed again and this oven-dry weight is subtracted from the initial weight. The difference is then divided by the oven-dry weight.

Moisture is contained in the cell cavities (free water) and in the cell walls

(bound water). As the wood is dried, moisture first leaves the cell cavities. When the cells are empty but the cell walls are still full of moisture, the wood has reached a condition called the Fiber Saturation Point. For most woods this is about 30 percent.

The fiber saturation point is important because wood does not start to shrink until this point is reached. As the M.C. is reduced below 30 percent, moisture removed from the cell walls and they become smaller in size. For a one percent moisture loss below the fiber saturation point, the wood will shrink about 1/30th of the total possible shrinkage. If dried to 15 percent M.C., it will have been reduced by about one-half the total shrinkage.

Wood shrinks most along the direction of the annual rings and about one-half as much across these rings. There is practically no shrinkage in the length. As moisture is added to wood, it swells in the same proportion that the shrinkage has taken place.

EQUILIBRIUM MOISTURE CONTENT

A piece of wood will give off or take on moisture from the air around it until the moisture in the wood is balanced with that in the air. At this point the wood is said to be at equilibrium moisture content (E.M.C.). Since wood is exposed to daily and seasonly changes in the relative humidity of the air, it is continually making slight changes in its moisture content and, therefore, changes in its dimensions. This is the reason doors and drawers often stick during humid weather but work freely the rest of the year.

Ideally, a wood structure should be framed with lumber at a M.C. equal to that which it will attain in service. This is not practical since lumber with such a low moisture content is seldom available and would likely gain moisture during the construction stages. Standard practice is to use lumber with a moisture content in the range of 15 to 19 percent. In heated structures, it will eventually reach a level of about 8 percent. However, this will vary in different geographical areas.

The carpenter understands that some shrinkage is inevitable and makes allowances where it will affect the structure. The first, and by far the greatest change in moisture content occurs during the first year after construction, particularly during the first heating season.

When "green" lumber (in excess of 20 percent M.D.) is used, shrinkage will be excessive and it will be almost impossible to prevent excessive warping, plaster cracks, nail pops, squeaky floors and other difficulties.

SEASONING LUMBER

This is the process of reducing the moisture content to the required level specified by the grade and use. In air-drying, the lumber is simply exposed to the outside air. It is carefully stacked with stickers (wood strips) between layers so air can circulate through the pile. Boards are also spaced apart in the layers so air can move vertically. Air-drying is a relatively slow process and often creates additional defects in the wood.

Lumber is kiln-dried by placing it in huge ovens where the temperature and humidity can be carefully controlled. When the green lumber is first placed in the kiln, steam is used to keep the humidity high while the temperature is kept at a low level. Gradually the temperature is raised and the humidity reduced. Fans are used to keep the air in constant circulation over the surface of the wood.

LUMBER DEFECTS

A defect is an irregularity occurring in or on wood that reduces its strength, durability or usefulness. It may or may not detract from appearance. For example, knots commonly considered a defect may add to the appearance of pine paneling. An imperfection that impairs only the appearance of wood is called a blemish. Some of the common defects include:

-KNOTS: Caused by an imbedded branch or limb of the tree. They are generally considered to be strength reducing-the amount depending upon the type, size and location.

-SPLITS and CHECKS: A separation of the wood fibers along the grain and across the annular growth rings. Usually occurs at the ends of lumber--a result of uneven seasoning.

-SHAKES: A separation along the grain and between the annular growth rings. Likely to occur only in species with abrupt change from spring to summer growth.

-PITCH POCKETS: Internal cavities that contain or have contained pitch in either solid or liquid form.

-HONEYCOMBING: Separation of the wood fibers in the interior section of the tree. May not be visible on the surface of boards.

-WANE: The presence of bark or the absence of wood along the edge of the board. It forms a bevel and reduces the width.

-BLUE STAIN: A discoloration caused by mold-like fungi. Objectional in appearance in some grades of lumber but has little or no effect on strength.

-DECAY: A disintegration of wood fibers due to fungi. Early stages of decay may be difficult to recognize. Advanced stages result in wood that is soft, spongy, and crumbles easily.

-HOLES: Holes in lumber will lower the grade. They may be caused by handling equipment or by wood boring insects or worms.

-WARP: Any variation from true or plane surface. May include any one or combination of the following: cup, bow, crook, and twist (also called wind).

GRADES (SOFTWOODS)

Basic principles of grading lumber are formulated by the American Lumber Standards Committee and are published by the U.S. Department of Commerce. Detailed rules are developed and applied by the various associations of lumber producers--Western Wood Products Association, Southern Pine Inspection Bureau, California Redwood Association and others. These agencies publish and distribute grading rules for the species of lumber produced in their regions and maintain qualified personnel who supervise grading standards at sawmills.

Basic classifications of softwood grading include boards, dimensions, and timbers. Another classification called Factory and Shop Lumber is graded primarily for remanufacturing purposes. It is used by millwork plants in the fabrication of windows, doors, moldings and other trim items.

The carpenter must understand that quality construction does not require that all lumber be of the best grade. Today, lumber is graded for specific uses and, in a given structure, several grades may be appropriate. The key to good economical construction is the proper use of the lowest grade which is suitable for the purpose.

GRADES (HARDWOODS)

Grades for hardwood lumber are established by the National Hardwood Lumber Association. FAS (first and seconds) is the best grade and specifies that pieces be no less than 6 in. wide by 8 ft. long--and yield at least 83 1/3 percent clear cuttings. The

next lower grade is Selects and permits pieces 4 in. wide by 6 ft. long. A still lower grade is designated as No. 1 Common and is expected to yield 66 2/3 percent clear cuttings.

LUMBER STRESS VALUES

In softwood lumber, all dimension and timber grades except Economy and Mining are assigned stress values. Slope of grain, knot sizes and knot locations are critical considerations. There are two methods of assigning stress values, "visual" and "machine rated." In the latter method, lumber is fed into a special machine and subjected to bending forces. The stiffness of each piece (modulus of elasticity) is measured and marked on each piece. Machine stress-rated lumber (MSR) must also meet certain visual requirements.

LUMBER SIZES

When listing and calculating the size and amount of lumber, the nominal dimension is always used. The figure on the following page illustrates the nominal and dressed sizes for various classifications of lumber used by the carpenter. Note that nominal sizes are sometimes listed in quarters. For example: 1 1/4 in. material is given as 5/4. This nominal dimension is its rough unfinished measurement. The dressed size is less than the nominal size as a result of seasoning and surfacing. Dressed sizes of lumber are established by the American Lumber Standards and applied consistently throughout the industry.

FIGURING BOARD FOOTAGE

The unit of measure for lumber is the board foot. This is a piece 1 in. thick and 12 in. square or its equivalent (144 cu. in.). Standard size pieces can be quickly calculated by visualizing the board feet included. For example: a board 1 x 12 and 10 ft. long will contain 10 bd. ft. If it were only 6 in. wide, it would be 5 bd. ft. If the original board had been 2 in. thick, it would have contained 20 bd. ft. The following formula can be applied to any size piece where the total length is given in feet:

$$\text{Bd. ft.} = \frac{\text{No. pcs.} \times T \times W \times L}{12}$$

An example of the application of the formula is shown below. Find the number of board feet in 6 pieces of lumber that measure 1" x 8" x 14':

$$\text{Bd. ft.} = \frac{\overset{1}{\cancel{6}} \times 1 \times \overset{4}{\cancel{8}} \times 14}{\underset{2}{\cancel{12}}\ \underset{1}{}} = \frac{56}{1} = 56 \text{ bd. ft.}$$

Stock that is less than 1 in. thick is figured as though it were 1 in. When the stock is thicker than 1 in., the nominal size is used. When this size contains a fraction such as 1 1/4, change it to an improper fraction (5/4) and place the numerator above the formula line and the denominator below. For example: find the board footage in 2 pieces of lumber that measure 1 1/4" x 10" x 8'.

$$\text{Bd. ft} = \frac{\overset{1}{\cancel{2}} \times 5 \times \overset{5}{\cancel{10}} \times \overset{2}{\cancel{8}}}{\underset{2}{\cancel{4}}\ \underset{3}{\cancel{12}}} = \frac{50}{3} = 16\ 2/3 \text{ bd. ft.}$$

Use the nominal size of the material when figuring the footage. Items such as moldings, furring strips, and grounds are priced and sold by the lineal foot; thickness and width are disregarded.

PLYWOOD

Plywood is constructed by gluing together a number of layers (plies) of wood with the grain direction turned at right angles in each successive layer. An odd number (3, 5, 7) of plies are used so they will be balanced on either side of a center core and so the grain of the outside layers will run in the same direction: The outer plies are called Faces or face and back. The next layers under these are called Cross-Bands and the other inside layer or layers are called the Core. A thin plywood panel made of three layers would consists of two faces and a core.

There are two basic types of plywood; exterior and interior. Exterior Plywood is bonded with waterproof glues and can be used for siding, concrete forms, and other constructions that will be exposed to the weather or excessive moisture. Interior Plywood is bonded with glues that are not waterproof and is used for cabinets and other inside work where the moisture content of the panels will not exceed 20 percent.

Plywood can be secured in thicknesses of 1/8 in. to more than 1 in. with the common sizes being 1/4, 3/8, 1/2, 5/8 and 3/4 in. A standard panel size is 4 ft.

wide by 8 ft. long. Smaller size panels are available in the hardwoods.

PLYWOOD GRADES (SOFTWOODS)

Softwood plywood for general construction is manufactured in accordance with U.S. Product Standard PSI. This standard provides a system for designing the species, strength, type of glue and appearance.

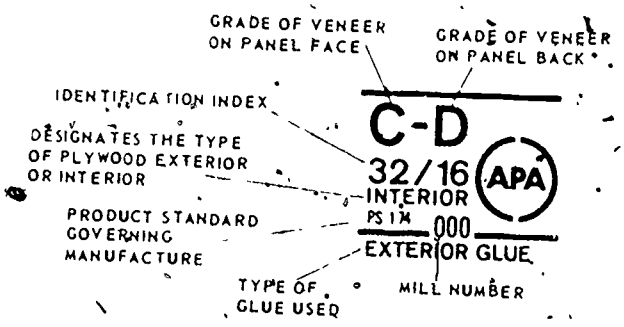
Many species of softwood are used in the manufacture of plywood and are separated into five groups--based on their stiffness and strength. Group 1 lists the species with the highest level of these characterists. A lettering system is used on the panel face, back and for the intter ply construction. The N grade is the highest grade and ranges downward through A to including D.

The American Plywood Association (APA) conducts a rigid testing program based on PSI-74 and member manufacturing companies are licensed to use their official grade-trademark. These grade-trademarks are stamped on each panel and cover both

Group 1	Group 2	Group 3	Group 4	Group 5
Apitong	Cedar, Port Orford	Alder, Red	Aspen	Basswood
Beech, American	Cypress	Birch, Paper	Bigtooth	Fir, Balsam
Birch	Douglas Fir 2	Cedar, Alaska	Quaking	Poplar, Balsam
Sweet	Fir	Fir, Subalpine	Calivo	
Yellow	California Red	Hemlock, Eastern	Cedar	
Douglas Fir 1(a)	Grand	Maple, Bigleaf	Incense	
Kapur	Noble	Pine	Western Red	
Keruing	Pacific Silver	Jack	Cottonwood	
Larch, Western	White	Lodgepole	Eastern	
Maple, Sugar	Hemlock, Western	Ponderosa	Black (Western Poplar)	
Pine	Lauan	Spruce	Pine	
Caribbean	Almon	Redwood	Eastern White	
Ocote	Bagtikan	Spruce	Sugar	
Pine, South.	Mayapis	Black		
Loblolly	Red Lauan	Engelmann		
Longleaf	Tangile	White		
Shortleaf	White Lauan			
Slash	Maple, Black			
Tanoak	Mengkulang			
	Meranti, Red			
	Mersawa			
	Pine			
	Pond			
	Red			
	Virginia			
	Western White			
	Spruce			
	Red			
	Sitka			
	Sweetgum			
	Tamarack			
	Yellow poplar			

appearance grades and engineered (structural) classifications.

A typical grade-trademark for an engineered grade of plywood is shown in the following figure. The C-D indicates that a C grade of veneer has been used on the face of the panel and a D grade on the back. Some engineered grades include an identification index which consists of a pair of numbers separated by a slash mark (/). The number on the left indicates the maximum recommended spacing of supports in inches when the plywood is used for roof decking. The number on the right indicates the maximum recommended spacing when the plywood is used for subflooring. In general, the higher the index number, the greater the stiffness.



The figure on the following page lists some engineered grades of plywood and includes descriptions and most common uses. A more complete list can be secured from the American Plywood Association.

PLYWOOD GRADES (HARDWOODS)

For plywood, it is common practice to designate in a general way the grade by the symbol G2S (good two sides) or G1S (good one side).

In addition to the various kinds, types and grades, hardwood plywood is made with different core constructions. The two most common are the veneer core and the lumber core. Veneer Cores are the least expensive and are fairly stable and warp resistant. Lumber Cores are easier to cut, the edges are better for shaping and finishing, and they hold nails and screws better. Plywood is also manufactured with a particle board core. It is made by gluing veneers directly to the particle board surface.

manufactured with one side smooth (S1S) or both sides smooth (S2S). It is available in thicknesses from 1/12 in. to 5/16 in. with the most common thicknesses being 1/8, 3/16 and 1/4 in. Panels are 4 ft. wide and come in standard lengths of 8, 10, 12 and 16 ft.

Particle board is made of wood flakes, chips and shavings bonded together with resins or adhesives. It is not as heavy as hardboard (about 40 lbs. per cu. ft.) and is available in thicker pieces.. Particle board may be constructed of layers made of different size wood particles; large ones in the center to provide smoothness. Extensive use is made of particle board as a base for plastic laminates and as a core for plywood. It is available in a wide range of thicknesses from 1/4 in. to 1 7/16 in. The most common panel size is 4 x 8 ft.

The unit of measure for plywood, hardboard and particle board is the square foot (sq. ft.). A standard 4 ft. x 8 ft. panel contains 32 sq. ft. Prices are quoted per square foot on the basis of full panel purchase and vary widely depending on the kind, thickness and grade.

WOOD TREATMENTS

Wood and wood products can be protected from attack by fungi, insects and borers by the application of special chemicals or wood preservatives. The degree of protection depends on the effectiveness of the chemical and how thoroughly it penetrates the material. Millwork plants employ extensive treatment processes in the manufacture of such items as door frames and window units.

There are two general classes of wood preservatives: oils, such as creosote, and petroleum solutions of pentachlorophenol; and certain salts that can be dissolved in water. The selection of a preservative should be based on its effectiveness in protecting the wood and also on any side effects that may result--discoloration of painted surfaces or objectionable odors.

A number of commercially prepared preservatives are available for on-the-job application. Study the manufacturer's directions and recommendations carefully. Use special precautions in handling solutions since some contain toxic chemicals and may also create a fire or explosion hazard during application.

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HANDLING AND STORAGE

Building materials are expensive and every precaution should be taken to maintain them in good condition. After they are delivered to the construction site, this becomes the responsibility of the carpenter.

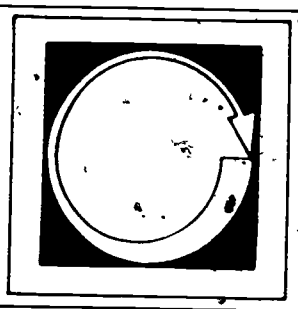
Piles of framing lumber and sheathing should be laid on level skids raised at least 6 in. above the ground. Be sure all pieces are well supported and are lying straight. Cover the material with canvas or waterproof paper, laid to shed water. Polyethylene film provides a watertight covering.

Exterior finish materials, door frames and window units should not be delivered until the structure is partially enclosed and the roof surface complete. In cold weather, the entire structure should be enclosed and heated before interior finish and cabinetwork are delivered and stored.

When finish lumber is received at a higher or lower moisture content than it will attain in the structure, it should be open stacked with wood strips so air can circulate freely around each piece.

Plywood, especially the fine hardwoods, must be handled with care. Sanded faces become soiled and scarred if not protected. In storing the panels should be laid flat.

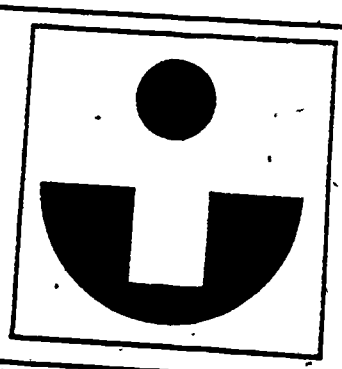
Self Assessment



Complete the statements below by writing the appropriate word in the blank provided.

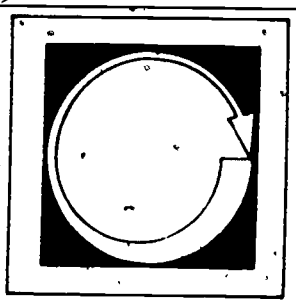
1. Lumber may be classified as either _____ or _____.
2. Lumber used for framing and outside finish should be dried to a moisture content of _____ percent.
3. M.C. means _____.
4. Seasoning lumber is the process of reducing the moisture content. It can be done in two ways: _____ and _____.
5. A _____ is an irregularity occuring in wood that reduces its strength.
6. There are two methods of assigning stress values to lumber. They are _____ and _____.
7. There are two size terms applied to lumber. They are _____ and _____.
8. The type of wood product which has crossbands and core is _____.
9. _____ is made of refined wood fibers.
10. _____ is made of wood flakes, chips and shavings bonded together.

Self Assessment Answers



1. hardwood, softwood
2. 15
3. moisture content
4. air, kiln
5. defect
6. visual, mechanical
7. nominal, dressed
8. plywood
9. hardboard
10. particle board

Post Assessment



Below each statement or question are three completing phrases or answers. Select the correct one and write its corresponding letter in the blank provided.

1.____The moisture in wood is called:
   a. sap
   b. water
   c. xylum

2.____Equilibrium moisture content is the balance between moisture in the:
   a. stack of wood
   b. knots and grain
   c. wood and air

3.____Wood, being dried, starts to shrink at the:
   a. equilibrium point
   b. fiber saturation point
   c. moisture content point

4.____Reducing woods' moisture content to a specified level is called:
   a. kilning
   b. curing
   c. seasoning

5.____Which of the following is not a lumber defect?
   a. long grain
   b. knot
   c. wane

6.____Which of the following is not a lumber grade?
   a. common
   b. interior
   c. selects

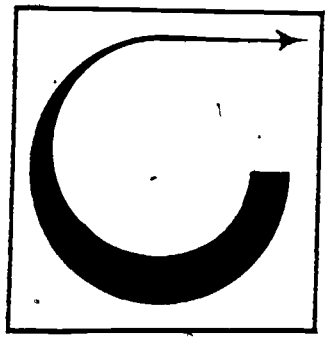
7.____Which of the following is smaller?
   a. common size
   b. nominal size
   c. dressed size

8.____If a piece of lumber measures 6' long by 1' wide by 2" thick, it contains how many board feet?
   a. 24
   b. 6
   c. 12

9.____There are two classes of wood preservatives. They are:
   a. milks and salts
   b. waters and salts
   c. oils and salts

10.____Open stacking means stacking lumber:
   a. with wood strips or laths
   b. so the sun can dry it
   c. so it can be sanded on the open beveled side

Instructor Post Assessment Answers



1. a
2. c
3. b
4. c
5. a
6. b
7. c
8. c
9. c
10. a