



**Credits: 6**

**Learning hours: 60Hrs**

**Sector: Agriculture**

**Sub-sector: Forestry**

**Module Note Issue date: June, 2020**

### **Purpose statement**

This module describes the skills and knowledge required to produce, treat and deliver good quality and quantity timbers to the customers. These practices are of great importance for the learners to cope with wood value chain in wood industries.

The module will allow the learner to prepare tools, equipment and materials for timber conversion, convert timber and preserve timber.

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## Learning Unit 1: Prepare tools, equipment, material and materials for timber conversion

### LO 1.1 –Identify tools, equipment and materials for timber conversion

#### Topic 1: Types of sawing tools, equipment and materials




- ✓ Mobile/ half stationary: Those are hand and portable power tools whereas portable means hand-held and can be moved from one place to another. They have obvious advantages in mobility.


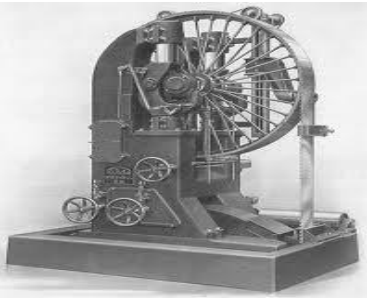



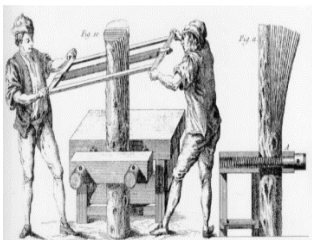
Some of those tools are: hammer, chisels, wrenches, hand saw, two men saw, coping saw, bow saw, chain saw, panga and hammer.






- ✓ Heavy duty/ stationary: Those are powered tools that are mounted on a stand and not typically moved around from location to location. Large equipment and fixed machinery are covered in a separate procedure called machine and equipment. Stationary often have advantages in speed and precision, they are not only cut faster but the cuts are smoother, straighter and squarer.



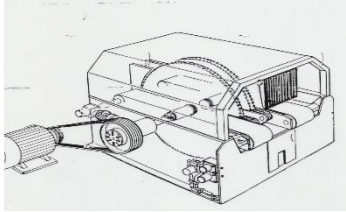


Eg: table saw, band saw, jointer, and Thickness planer and combination saw.

#### Topic 2: Description of tools, equipment and materials




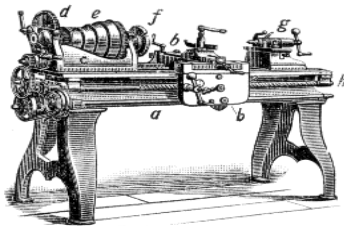


No	Sawing devices	Description
1	Hand saw 	<ul style="list-style-type: none"><li>- Is a saw that has one wooden handle and a metal blade</li><li>- Is used by one person</li><li>-It operates as left hand saw or right hand saw according to the position of a sawyer</li></ul>
2.	Two-men saw or saw handed by 2 persons/pitsaw/whip saw or lumberman saw 	<ul style="list-style-type: none"><li>-Is a saw with 2 handles at both ends intended for use by two sawyers.</li><li>-It has a narrow or wide blade allowing wedges to be more easily inserted or giving it more strength</li><li>-a large two handed saw formerly used to cut logs into planks, one man stood above the log and other in a pit below.</li></ul>
3.	Chain saw 	<ul style="list-style-type: none"><li>-It is a portable, mechanically powered handled saw which cuts with a set of teeth attached to a rotating chain that runs along a guide bar</li><li>-Most of them are gasoline engine to power the chain and other are driven by an electric motor</li><li>-The saw incorporates a set of teeth a long a moving chain</li><li>-The chain moves by rotating around a steel as you cut the log</li><li>-As the chain rotates , it slices through the wood with very</li></ul>







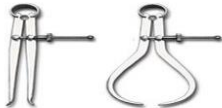

		high power and an even greater forces
4.	<p>Band saw:</p>  <p>Vertical band saw</p>  <p>horizontal band saw</p> 	<p>-It is a stationary power saw and is one of types of electric saws</p> <p>-It has large pulley above and below the cutting table to move a continuous band with fine teeth to cut through most materials</p> <p>-It has a long blade which is equipped with varying degrees of some teeth</p> <p>-It is the most accurate and precise cutting machine</p> <p>Eg: Horizontal ,vertical and portable band saw</p>
5.	<p>Circular saw</p> 	<p>-It is a power saw using toothed or abrasive disc or blade to cut different material using a rotary motion spinning around an arbor and mounted on the table</p> <p>-It may be hand-held or mounted to a machine</p> <p>-It is composed of frame and roller bed</p> <p>-It has a splitting knife and rakeshalf</p> <p>-It is relatively lightweight and comes with a handled design however you must push the saw manually to cut the log</p>
6.	<p>Frame saw/slash saw</p>  	<p>-Is a type of saw which consist of a relatively narrow and flexible blade held under tension within a wooden rectangular frame called sash or gate.</p> <p>-The blade is held perpendicular to the plane of the frame so that material being cut passes through the center of the frame.</p> <p>-Most saw blades are in use and installed at the order</p> <p>-Frame saw for use with the wood are rip saw operates as a hand saw</p>

7.	<p>Bow saw</p> 	<ul style="list-style-type: none"> <li>-It is saw with a long thin blade attached to a metal frame which is designated as a bow shape</li> <li>-Is a type of frame saw</li> <li>-Its thin blade is held in tension by a frame</li> </ul>
8.	<p>Cross-cut saw/bucking saw/felling saw</p> 	<ul style="list-style-type: none"> <li>-Is any saw designated for cutting wood perpendicular to the wood grains</li> <li>-It may be small or large with small teeth closer together for fine work</li> <li>- It can be a hand or a power tool</li> <li>-It includes a blade and a handle. The blade edge below the handle is the heel and the opposite is the toe.</li> <li>-Is a saw that has larger teeth compared to the others traditional hand saw</li> <li>-The blade is also thick</li> <li>-It is usually big saw and has slightly big and wide spaced teeth.</li> </ul>
9.	<p>Ripping saw</p> 	<ul style="list-style-type: none"> <li>-It is a specialized hand saw designated for cutting the wood in the direction of the wood grains</li> <li>-It has the same size as crosscut , the only difference is in use, size and shape of the teeth</li> </ul>
10.	<p>Coping saw</p> 	<ul style="list-style-type: none"> <li>-It is a type of bow saw designated for cutting wood patterns, shape and design in manufacturing wood products</li> <li>-It uses a very thin metal blade stretched on a metal frame to make turning cuts on wood, plastics or metal depending on the blade selected</li> </ul>
11.	<p>Combination saw</p> 	<ul style="list-style-type: none"> <li>-Is a wood working machine that combines the functions of two or more separate machines into a single unit</li> <li>-It is the most commonly used blades because they are multipurpose</li> <li>-They can be used for a combination of purposes where as it is used in planning, cutting, moulding, drilling and cross-cutting or ripping and mitering</li> <li>-This type of saw has combination tooth configuration with group of 5 teeth, 4 alternate top bevel (ATPR) and 1 flat top and a large gullet after each group</li> <li>-The main characteristics of this saw is the tooth pattern having around 60 ATBR teeth</li> </ul>

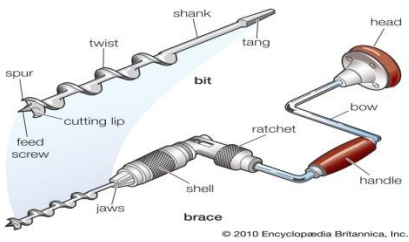

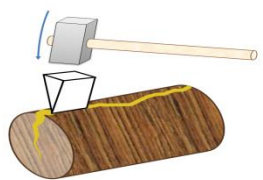



		
12.	<p>Jig saw</p> 	<ul style="list-style-type: none"> <li>-Is a very powered handled saw made up of an electric motor and a reciprocating saw blade</li> <li>-it has short, fine toothed blade which moves up and down at a variable speed.</li> <li>-It has narrow blade</li> <li>-It has a beveling technique of up to 45°</li> <li>-A jig saw's blade is easy to power and designated with varying teeth for every inch.</li> <li>-There is a power jig saw and a battery powered jig saw</li> </ul>
13.	<p>Gang saw/multiple circular saw</p> 	<ul style="list-style-type: none"> <li>-Is a saw having several parallel blades for making simultaneous cuts.</li> <li>-Is a series of straight saw blades set in a vertical frame.</li> <li>-An arrangement of saw and set in one frame. These have more than two blades and cut two slabs and several boards at the same time. The saws are mounted on the same arbor.</li> </ul>
14.	<p>Table saw/bench saw</p> 	<ul style="list-style-type: none"> <li>-Is a stationary power woodworking tool consisting of a circular saw blade mounted on an arbor that is driven by an electric motor either directly by belt or by gears</li> <li>-It has a large circular blade protruding through the face of the table.</li> <li>- Rip fence can be adjusted to width to help guide the board as it pushed through the blade</li> </ul>
15.	<p>Reciprocating saw/sawzall</p> 	<ul style="list-style-type: none"> <li>-It is a type of machine powered saw in which the cutting action is achieved through a push and pull(reciprocating) motion of the blade</li> <li>-Like jig saw, it has a short, fine toothed blade which moves back and forth very quickly</li> <li>-They are sometimes called saw zall referring to the original manufacturer of this saw.</li> </ul>








		
16.	<p>Miter saw/power miter box/miter saw</p> 	<p>-Most saws are commonly referred to as chop saw</p> <p>-They are relatively small and portable with common blade sizes ranging from eight to twelve</p>
15.	<p>Thickness planer/thicknesses or planer</p> 	<p>-Is a woodworking machine to trim boards to a consistent thickness throughout their length and flat on both surfaces</p> <p>-It consists of three elements: a cutter head which contains the cutting knives, a set of rollers which draw the board through a machine and a table which is adjusted relative to the cutter head to control the resultants thickness of the board</p>
16.	<p>Lathe</p>  <p style="text-align: center;">Lathe, p. 1218.</p>	<p>-Is a machine tool that rotates a work piece about an axis of rotation to perform various operations such as cutting, sanding, drilling, deformation, facing and turning with tool that are applied to the work piece.</p>
17.	<p>Jointer</p> 	<p>-Is a stationary power tool has high end or professional grade jointer-planer discernible by the integral vacuum reservoir, metal blade and the very infeed and outfeed tables.</p> <p>-It is better known as surface planner, planer, flat top or buzzer</p>
18.	<p>Angle grinder/side grinder/disc grinder</p> 	<p>- It is a handheld power tool used for grinding abrasive cutting and polishing.</p> <p>- It can be powered by an electric motor, petrol engine or compressed air.</p> <p>- There are many kind of discs such as cut off disc (diamond blade), abrasive grinding disc, sanding disc, wire brush wheels and polishing pads.</p>
19.	<p>Surface planners</p>	<p>-Is one of several tools that is need in shop when you are going to mill or to square up rough lumber</p>

		
20.	Files/rasps 	-Are cutting tools of hardened steel in the form of bar or rod with many small cutting edges raised on its longitudinal surfaces
21.	G-Clamp 	-Is a type of clamp device -Is used by means of turning of turning the screw through the bottom of the frame until the desired state of pressure or release is reached
22.	Hand drill 	-Is a manual tool that convert and amplifies circular motion of the crank into circular motion of a drill -There are two types hand drill: manual and powered hand drill
23.	Mallet 	- Is a tool resembling a hammer but with a large head usually wooden, used to drive wedges , crushing, beating, flattening or smoothing
24.	Try square 	-Is a wood working tool used for marking and measuring -The square refers to the tool's primary use of measuring the right angle whereas try a surface is to check its straightness or correspondence to an adjoining surface.
25.	Inside and outside caliper 	-Are measuring tools which can be set from a sample of work,, from a ruler or from a micrometer
26.	Marking gauge/scratch gauge 	-It is used in woodworking, joinery and metal working to mark out lines for cutting or other operations.



27.	<p><b>Brace and auger bit</b></p>  <p>© 2010 Encyclopædia Britannica, Inc.</p>	<p>-Is a hand operated tool used with a bit (drill bit or auger) to drill holes in wood. Pressure is applied to the top and the tool is rotated with a U-shaped grip</p>
28.	<p><b>Pliers/pincers</b></p> 	<p>-Are the multipurpose hand tool with opposing jaws for gripping, bending and cutting.</p>
29.	<p><b>Wedge</b></p> 	<p>-and one of the 6 classical simple machines. Is a triangular shaped tool and is portable inclined plane</p>
30.	<p><b>Hammer</b></p> 	<p>-It is a tool consisting of a weighted head fixed to a long handle that is swung to deliver an impact to a small area of object</p>
31.	<p><b>Nails</b></p>	<p>-Is a slender metal shaft that is pointed at one end and flattened at the other end and is used for fastening one or more objects to each other.</p>
32.	<p><b>Panga</b></p>	<p>-Is a tool used in sawing, the panga blade has 32.5 to 45 cm long and 3mm thick</p>
33.	<p><b>Folding ruler</b></p> 	<p>-Measuring instruments similar In function to ruler is made portable by folding</p>
34.	<p><b>Sharpening stone</b></p> 	<p>-Is a tool which has apart used to sharp metal or a blade</p>
35.	<p><b>PPE</b></p>	<p>-Is a personal protective equipment that will protect the</p>

		user against health or safety risks at work
36.	Centre punch 	-It is a hand tool consist of a metal rod with a conical point for making an indentation, to allow a drill to make a hole at the same spot without slipping
37.	Rope/cable/wire/strand	-It is a thick cord or wire that is made by twisting together several thinner cords or wires.
38.	Pencil	-It is an implement tool for writing or drawing, constructed of a narrow, solid pigment core in protective casing that prevents the core from being broken and /or marking the user's hand
39.	Wet stone 	-Is a tool which has a part that is used to sharp a blade
40.	Grinder or grinding machine Hand grinding machine 	-It is one of power tool or machine used for grinding and is a type of machining using an abrasive wheel as the cutting tool -It is a machine type that applies rough wheels as the surface against which objects are cut -It is used to precisely finish and shape the given material with high surface quality and low surface roughness
41.	Grinding wheel 	-Is a wheel composed of an abrasive compound a and used for various grinding(abrasive cutting) and abrasive machining operations
42.	Grinding stone 	-Is a round sharpening stone used for grinding or sharpening ferrous tools



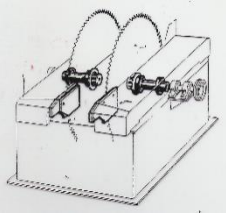
43.	Chisel 	-Is a tool with a characteristically shaped cutting edge of blade on its end.
44.	Spanner/wrench 	-Is a tool used to provide grip and mechanical advantages in applying torque to turn object usually rotary fasteners.
45.	Double slabber 	<p>-This has two saw blades and it cuts two slabs at a time, one from each side of the log.</p> <p>-The sawblades are mounted on the same arbor and their distance can easily be changed by a hydraulic operated thickness divisor.</p>

Table 1: Tools, materials and equipment description

### ● Topic3: Description of hack, rip and chain saw

#### ✓ Description of rip and hack saw

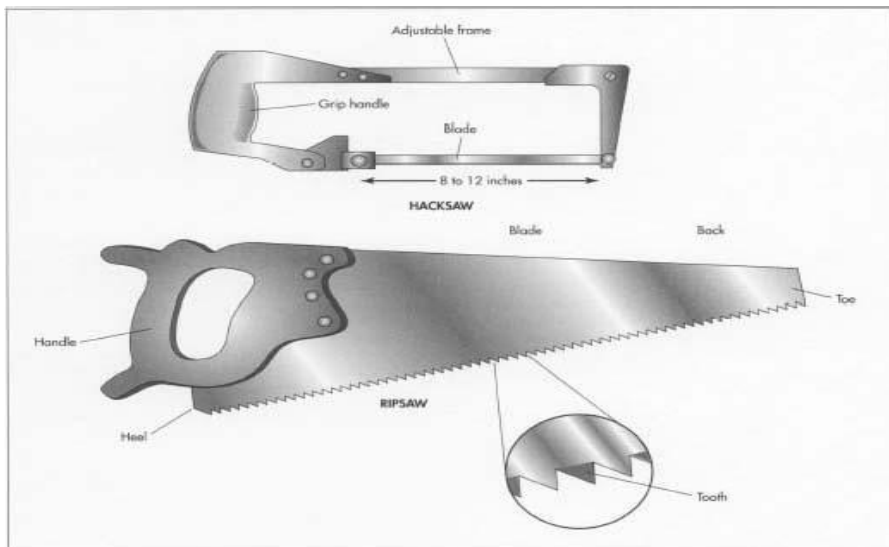


Figure 1: Hack and rip saw description

- ✚ Heel: The end closest to the handle.
- ✚ Toe: The end farthest from the handle.
- ✚ Front: The side with the teeth (the "bottom edge").
- ✚ Back: The side opposite the front (the "top edge").
- ✚ Teeth: Small, sharp protrusions along the cutting side of the saw.

✚ Fleam: The angle of the faces of the teeth relative to a line perpendicular to the face of the saw.

✓ Description of chain saw



Figure 2: Chain saw description

#### Topic 4: Description of saw teeth and saw angles

✓ Description of Saw tooth

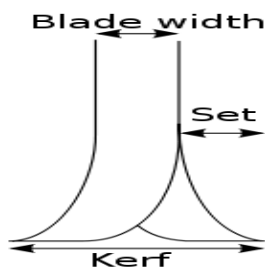


Figure 3: Saw tooth

✚ Tooth: The tooth angle is the angle made by the two sides of tooth it means back and face of the same tooth.

✚ Kerf: The width of a saw cut, which depends on several factors: the width of the saw blade; the set of the blade's teeth.

✚ Set: The degree to which the teeth are bent out sideways away from the blade, usually in both directions.

✓ Description of angles of a saw tooth on sawing blade

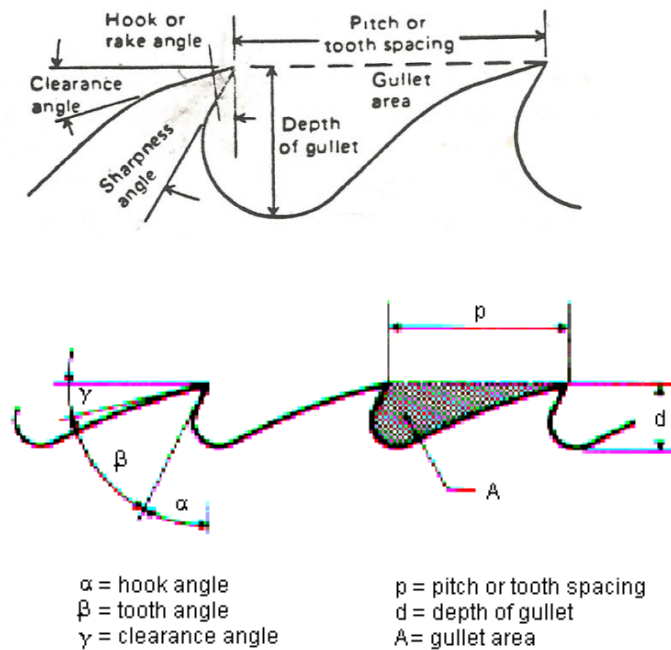


Figure 4: Saw angles

- ✚ Pitch/ Step: This is the distance between two adjacent teeth. It affects the power required to drive the saw, the ease of feeding, the quality of sawing and the wear on the teeth.
- ✚ A gullet: This is the space between adjacent teeth or the valley between the points of the teeth. Its function is to retain and remove saw dust produced by the teeth. The gullet must have a proper shape and size, if it is to perform its function well.
- ✚ A Hook / Rake: Is the angle between the front of the tooth and a perpendicular line to the saw blade passing through the tooth point. The size of this angle affects the ease of cutting and the quality of the sawn surfaces. A large angle of hook requires minimum energy to drive the saw.
- ✚ Clearance angle: the clearance angle is the angle made by top line of teeth and back of the tooth; it is there for collecting the sawdust/ wood chips and carry them out of cut during sawing process.

This provides free space between the line of cutting and top of the tooth. The size of this angle seems not to be of great importance of the saw. It does not take part in the cutting action of the tooth, its only purpose is to prevent the advancing wood from pressing on tops of the teeth.

#### Topic 4: Functions of tools, equipment and materials

No	Sawing devices	Functions
1	Hand saw	- It is a saw that is used to saw small logs and small timbers.
2.	Two-men saw or saw handed by 2 persons/pitsaw/whip saw or lumberman saw or felling saw	-This type of saw is adapted in the activity of forest exploitation like tree felling and bucking
3.	Chain saw	-It is used in activities such as tree felling, limbing, bucking, pruning, cutting firebreaks in wildland fire suppression and harvesting of firewood. -It is used to cut the big lumbers and the large wood pieces of wood including trees.
4.	Band saw: Vertical and horizontal band saw	-Small band saws are mainly used in industries and furniture factories  -Heavy band saw are used for various type of saw operations in large and small saw mill like planning and furniture plant. -It is used to cut curves or to cut irregular shapes -Band saws are used in resawing or ripping timber into thinner slabs
5.	Circular saw	-It is a tool for cutting many materials such as wood, masonry, plastic or metal.
6.	Frame saw/slash saw	-It is used for cutting wood or stone
7.	Bow saw	-It is saw used for straight or curved cuts -It is used for cutting big pieces of wood and cutting down tree branches
8.	Cross-cut saw/bucking saw/felling saw	-Is a saw that is used for cutting wood across wood grains -It can be used in wood working and in log bucking
9.	Ripping saw	-It is used mainly for the purpose of cutting and sawing of wood -It is used to make cuts in rip way or along the wood grains
10.	Coping saw	-It is a type of bow saw used to make external shapes and interior cuts out in woodworking or carpentry -It is widely used to cut moldings
11.	Combination saw	-It is a saw designated to, planning, moulding, milling,



		mortising and make a design
12.	Jig saw	<ul style="list-style-type: none"> <li>-It used to make both straight and curved cuts/lines on wood and other material</li> <li>-It used to make complexes shapes</li> <li>-It is also work well for making crosscuts on timbers</li> </ul>
13.	Gang saw/ multiple circular saw	<ul style="list-style-type: none"> <li>-Is a saw used in the dimension stone industry and stone cutting factory</li> <li>-It can also be used in sawing</li> </ul>
14.	Table saw	-The most basic use for a tables aw is to take large sheets of material usually wood and to safely cut it down into smaller pieces to be used for other projects
15.	Reciprocating saw	-It is used in construction and demolition work
16.	Miter saw/power miter box/miter saw	-It makes cuts by pulling a spinning circular saw blade
15.	Thickness planer	-It is used to trim boards
16.	Lather	-Is a machine used to perform various operations such as cutting, sanding, drilling, deformation, facing and turning with tool that are applied to the work piece.
17.	Jointer	<ul style="list-style-type: none"> <li>-It has the primary function of producing the flat edges on a board prior to joining them edge to edge to produce wider boards.</li> <li>-It is an essential equipment to make a flat surface along the length of a board.</li> </ul>
18.	Grinder or grinding machine	<ul style="list-style-type: none"> <li>-It may be used for removing excess material from a piece of wood</li> <li>-It is used for grinding purpose</li> </ul>
19.	Surface planners	<ul style="list-style-type: none"> <li>-Is used in the initial preparation of log producing flat faces and square edges</li> <li>-It also has a separate function of reducing the thickness of the board so it is used as thickness planner and also as a surfacer</li> </ul>
20.	Files/rasps	<ul style="list-style-type: none"> <li>-Are used to remove/smooth rough and sharp edges from cut metal</li> <li>-Are used for forming objects</li> <li>-Are used to shape materials by slowly cutting away small amount</li> </ul>
21.	G-Clamp	-It is typically used to hold a wood or a metal and often used in carpentry and welding
22.	Hand drill	<ul style="list-style-type: none"> <li>-It used to drive screw and other fasteners</li> <li>-Is an effective tool for drilling holes into the woo or other</li> </ul>

		material
23.	Mallet	-It used to reduce the force driving the cutting edge of a chisel giving better control -It is also use in carpentry to knock wooden pieces together or to drive dowels or chisel
24.	Try square	-It is used for marking and measuring a square piece of wood or other material
25.	Inside and outside caliper	-It is used for measuring the inside and outside diameters of cylindrical objects
26.	Marking gauge	-It is used in scribing lines parallel to a reference edge or wood surface
27.	Brace and auger bit	-It used to drill holes usually in wood
28.	Pliers	-They are useful for bending, cutting and compressing a wide range of materials
29.	Wedge	-It can used to separate two objects or portions of an object, lift up an object or hold an object in place.
30.	Hammer	-It is used to drive or to remove nails
31.	Nails	-Are used for fixing the parts of material -Are commonly used to fasten pieces of wood together -Are used in construction and carpentry
32.	Panga	-It is used in agriculture and forestry activities like cutting
33.	Folding ruler	-It can be used for measuring both small spaces and longer distances -It can also be used to measure a point which is difficult to reach
34.	Sharpening stone	- It is used to sharpen the edges of steel tools and implements through grinding and honing
35.	PPE	-Are used for body protection
36.	Centre punch	-Is used for making the location of a hole in the wood or other material -Is used to mark the center of a point
37.	Rope	-Ropes are used for jobs such as pulling cars, tying up boats or tying things together
38.	Pencil	-Is used in marking or writing
39.	Wet stone	-It is used to sharpen the edges of steel tools and implements through grinding and honing
40.	Files/ rasps	-Are used for smoothing wood or metal
41.	Screw driver	-Is used for holding wood or metal parts together -Is used for loosening or tightening screw
42.	Chisel	-It is used for carving or cutting a hard material such as a wood, stone or metal by hand, stuck with a mallet or a mechanical power

43.	spanners	-Is used for gripping the side of timber when loosening or tightening
44.	Double slabber	-Is used for removing slabs from the log











*Table 2: Tools, materials and equipment functions*

## LO 1.2 – Select and adjustment of tools and equipment

### Topic 1: Adjustment of sawing tools, materials and equipment

- ✓ Selection of sawing tools, materials and equipment

Many factors are considered during tools and material selection. Those are:

-  Size of timber
-  Size of raw material (Log)
-  End use
-  Working conditions
-  Species
-  Log characteristics
-  Availability of tools and material
-  Log conditions
-  Economical means
-  Properties of tool and materials.

- ✓ Adjustment instructions of sawing tools, equipment and materials

Adjustment instructions of the information on how tool and material operate and standard measures are given from the manufacturer written on the catalogue.

Adjustment of tools, material and equipment can be done before using them in sawing activities. Recalibration, careful handling, manipulation and checking all parts of tool and materials are necessary before use it.

-  Screw drivers
-  Hammer
-  Spanner
-  Pincers/pliers
-  Washers

- ✓ List of sawing machines accessories: Those are tools and material which are not principal but can be used to support or to help the main sawing machines. Those are: Electric engine, Sawing table, Cutting and Cutting chain.

## LO 1.3 – Maintenance of sawing tools, materials and equipment

### Topic 1: Maintenance instructions of tools and equipment

- ✓ The first rule for the guarantee of a long and useful life for any tool is that, tool and materials should be used correctly and used according to the type of work for which it was intended.
- ✓ Regular sharpening of certain tools and material such as: machete, axe and saw before and after use.
- ✓ Metal parts should be regularly cleaned with oil to avoid rust and replaced any worn out parts before they finally breakdown.
- ✓ Remove dusts after use by cleaning with a soft tissue or small part of cloth
- ✓ PPE must be washed, dried and ironed after use
- ✓ Oil and grease the movable parts
- ✓ When sharpening always follow the existing level of the blade.
- ✓ Avoid using an electric grindstone as these can very easily overheat the metal and the damage the tool.

### Topic 2: Keeping instructions of tools and equipment

Keeping instructions of tools and materials are the followings:

- ✓ Tools and materials should be kept in a cool and dry place
- ✓ Tools and materials should be kept in a safe place
- ✓ Tools and materials should not be left lying around after use
- ✓ When they are in the store, you must avoid any contact of them and the wet soil, rainfall and humidity Tools and materials should be kept
- ✓ Store tools and materials in a clean place
- ✓ Tools and materials must be stored in a good conditions of store ( $O_2$ ,  $T^\circ$ , H%, light, rainfall).

### Topic 3: Safety precautions

Those are precautions, rules and instructions for avoiding risks and accidents during performing sawing activity and using any tools and materials. Safety measures are also given for protecting the body against injuries and danger.

- ✓ During sawing activities, a sawyer must wear PPE
- ✓ Use a well maintained tools and material
- ✓ Don't use damaged or not sharpened saw while sawing
- ✓ Work in well ventilated place
- ✓ Work in good conditions of climate
- ✓ Have basic information about first aid skills
- ✓ In the case of accidents or fracture, report and use bandage
- ✓ Avoid beverage during sawing activities



## Learning Unit 2 – Perform log sawing

### LO 2.1 – Identify timber conversion methods

#### Topic1: Identification of timber conversion methods

There are the different methods of sawing, those are:

- ✓ Through and through sawn method
- ✓ Quarter sawn method
- ✓ Cant sawn method
- ✓ Taper sawn method
- ✓ Grade sawn methods
- ✓ Through and through sawn method

This method is also called plain sawn or crown sawn method.

It is the most common method today and most widely used. It involves progressive cuttings of the log from one side to other side. Each additional cut is then made parallel to one before.

This method produces tangential boards where as a board is cut from the log and then turned to 90 degrees before taking the next cut. This process is continued until the entire log is cut. Tangential boards are used extensively in the building industry and are used for beams and joints.



Figure 5: Through and through and plain saw

#### ✓ Tangential(cant) sawing

This method is also called Tangential sawn method.

In cant sawing, the log two slabs on opposite sides of the log are first removed in one sawing plane which results to a cant by using a frame which is then turned to 90 degrees for sawing into boards. It produces tangential board. Softwood logs intended for boards and construction dimensional timber are normally cant sawn or live sawn method.

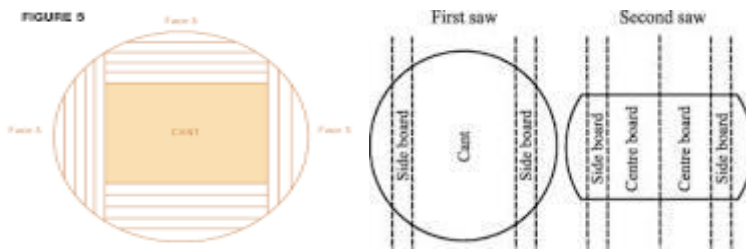


Figure 6: Cant sawing

### ✓ Quarter (rift or radial) sawing

This method is also called rift or radial sawn method because it produces radial boards.

The log is first cut into four quarters and then quarters are cut radially perpendicular to the growth rings of the log. This method produces nice straight appearance on the face of the board grains at angle of 60-90 degrees that are close to the surface of the board or more than 45 degrees.

Wood cut by this method is called quarter sawn if it is hardwood, if it is softwood is called edge grained or vertical grained.

It is rift sawn method when the cut falls between crown and quarter sawn. It produces linear gaining (grains) along a board at an angle of 30-60 degrees with optimum of 45 degrees reveal any grains.

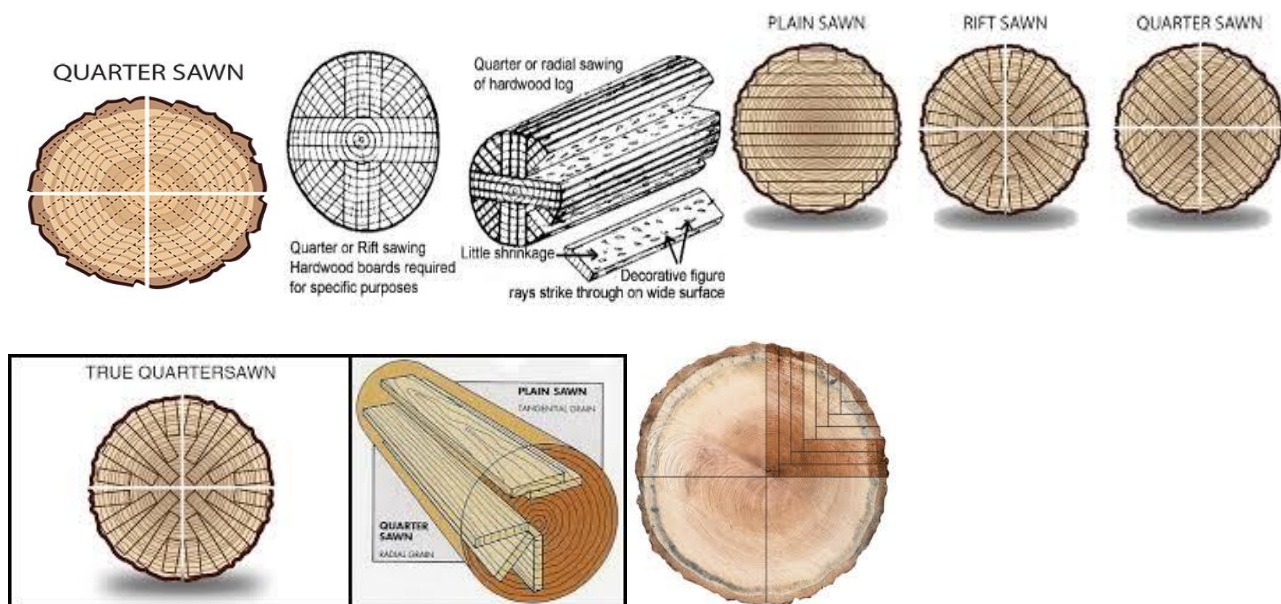
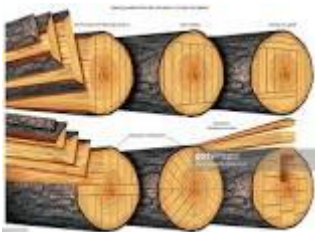


Figure 7: Quarter sawing, rift sawing and others

### ✓ **Grade sawing**

It is a method used often with hardwoods that saws all faces around the log turning as it needed to remove each board from the face promising the highest grade. It is aimed at high quality timber from the outer part of the log and structural timber from the inside.

The log was positioned so that visible defects primary knots were located on the edges of the sawing face. In most cases, the poorest face (face with defects) was sawed first without using taper set out. When the best face was sawed first, full taper set out was used. Thus three or more turns were made in grade sawing. Large log that produces high grade lumber are usually grade sawn in the same manner as hardwoods.



*Figure 8: Grade sawing*

### ✓ **Taper (live) sawing**

It is also called taper sawing method. It is the oldest method but the newest in America.

The log is cut straight through with each cut parallel to the last. This method produces mixtures of plain, quarter and lift sawn method. It results to all sawn lines parallel and minimizes a time. It is suitable when only boards are being sawn.

It is taper sawn method when the cut is oriented to the outside of the log. It produces good timbers that follow the growth rings. When the cutting to the centre of the log, the timbers are higher and stronger.

Taper sawing is the practice of adjusting the small end of a log on the sawmill deck until the outside of the log is in the same plane as the saw blade.

A tapered log usually a butt log decreases in diameter from one end to the other.

When a tapered log is cut into lumber, there generally is a yield loss at the large end and the lumber lost is often the clearest wood on the log. Methods for improving yield in tapered log include crosscutting logs into shorter segments and accepting shorter lumber, tapered sawing and live sawing.

Under all sawing methods, the log may be sawn split or half taper with sawn lines parallel to their central axis, full taper with sawn lines parallel to one side.

## Topic 2: Advantages and disadvantages of each method

### ✓ Through and through or plain method

Advantages	Disadvantages
-Boards are little expensive and wider	-They are more expensive
- It shrinks and swells less in thickness	-Boards can suffer to cupping, bowing or twisting when they are not dried or stored properly
-It is less susceptible to collapse in drying	-They are prone to shrinkage and swelling
-They may cost less because they are easier and faster to obtain timbers	
-Surface appearance less affected by round or oval knots compared to quarter sawn method	
-Boards can take nails without splitting	
-They are most economical	
-Expands and contracts less	

Table 3: Advantages and disadvantages of through and through

### ✓ Cant sawn method

Advantages	Disadvantages
-Less time consuming	-It require skills and experience
-More timbers have been got at time	-Less resistant to moisture
-Minimum number of labor is required as compared to other sawing methods	-Drying defects are observed
-Wider and stronger boards are obtained with less wood waste	

Table 4: Advantages and disadvantages of cant sawn method

✓ **Quarter sawn method or rift sawn method**

Advantages	Disadvantages
-it provides stronger timbers	-It requires more cuts
-They shrink and swell less in width	-It produces more wastes
-It wraps less than plain sawing method	-They are more expensive due to double or more cuts required
-They are less prone to cup or distortion/warping	-They have more wastage
-They are more decorative	-Boards are very narrow
-Radial faces show the beauty of the wood in most cases	-This method is very inefficient
-They hold paint better in some spp	-Most log left is unusable
-They produce attractive grain patterns	
-They are more resistant to warping or twisting	
-They are slightly stronger and stiffer	

*Table 5: Advantages and disadvantages of quarter sawn method*

✓ **Grade sawing method**

Advantages	Disadvantages
-It increase the value timbers	-It requires skills and experience
-It provide timber of good quality	-High wastage
	-It take a long time by comparing to others

*Table 6: Advantages and disadvantages of grade sawn method*

✓ **Taper sawn method or live sawn method**

Advantages	Disadvantages
-Good timbers free of defects	-Time consuming than other sawing methods
-It provide timber of high quality	-Portion of wood is lost by squaring the log to be sawn
	-Produces few number of timbers

*Table 7: Advantages and disadvantages of taper sawn method*

## 2.2 – Select timber conversion methods

### Topic 1: Identification of selection timber conversion factors

Selection of sawing method to be used depends upon different factors which are the followings:

- ✓ Types of sawing machines
- ✓ Log size (diameter, height and volume)
- ✓ Types of wood
- ✓ Log quality parameters (form, growth)
- ✓ Proportion of heartwood to sapwood
- ✓ Log characteristics and conditions
- ✓ Cost
- ✓ Future use (structural or decorative)
- ✓ Availability of tools and materials

## LO 2.3 – Apply timber conversion methods

### Topic 1: Standards operating procedures

- ✓ Every tool, material and equipment has special standards measures and standard procedures for manipulating them. The following procedures and safety precautions may be followed while operating tools and equipment.
- ✓ Wear PPE
- ✓ Before sawing check that machines are well adjusted and recalibrated
- ✓ Use tools and material following safety regulations
- ✓ When sawing keep hand away from saw blade
- ✓ Don't allow people get in sawing area
- ✓ When replacing or installing sawing blade make sure that power supply is disconnected
- ✓ Calibration of sawing machines



Different kind of sawing machines can be recalibrated before logs are converted into timbers those are:

-  Circular saw
-  Band saw
-  Chain saw
-  Table saw
-  Combinational saw

## Topic 2: Conversion efficiency (recovery)

Conversion efficiency of log into timbers is commonly expressed as Timber recovery factor LRF or as overrun.

LRF is the nominal board feet of timber divided by the cubic volume of logs. It is a more direct measure of timber conversion efficiency although the maximum potential.

Overrun is the nominal timber board feet divided by the board feet log scale. Overrun is a relatively poor measure of conversion efficiency because there is little relation between the log scale and the potential timber volume recovery.

Lumber/timber recovery (TR) is defined as the volume of sawn wood or timber expressed in percentage as a ratio between volume of timber and volume of log multiply a hundred. The net volume of timber recovered from the log is directly related to the accuracy of the timber size.

$$\text{Timber recovery (TR)} = \frac{\text{volume of timber}}{\text{Volume of log}} \times 100 \text{ or } \text{TR} = \frac{V_T}{V_L} \times 100$$

Example:

Length: 6 m, basal diameter: 35 cm, upper diameter: 30 cm and you are required to calculate the timber recovery if the waste for sawing and drying is 45%.

Answer:

According to Newton the formula of log volume is equal to:  $V=L \frac{(S_b+4S_m+S_t)}{6}$

Where:

- V: the volume of log
- L: Length
- $S_b$ : Cross sectional area of base
- $S_m$ : Cross sectional area of middle
- $S_t$ : Cross sectional area of top

$$S_b = \frac{\pi d^2}{4} = \frac{3.14 \times (35)^2}{4} = 961.625 \text{ cm}^2$$

$$S_t = \frac{\pi d^2}{4} = \frac{3.14 \times (30)^2}{4} = 706.5 \text{ cm}^2$$

$$S_m = \frac{\pi d^2}{4} = \frac{3.14 \times (32.5)^2}{4} = 829.15 \text{ cm}^2; \text{ where } d_m = \frac{d_1 + d_2}{2} = \frac{35 \text{ cm} + 30 \text{ cm}}{2} = 32.5 \text{ cm}$$

$$V = \frac{L(S_b + 4S_m + S_t)}{6} = \frac{6[961.625 + 4(829.15) + 706.5]}{6} = 3.323 \text{ m}^3$$

$$45\% \text{ of the log is loss for sawing and drying is equal to: } \frac{3.323 \text{ m}^3 \times 45}{100} = 1.49 \text{ m}^3$$

$$\text{The volume of timber will be: } 3.323 \text{ m}^3 - 1.49 \text{ m}^3 = 1.83 \text{ m}^3$$

$$\text{Timber recovery is: } TR = \frac{1.83 \text{ m}^3}{3.323 \text{ m}^3} \times 100 = 55\%$$

### Topic 3: Identification of Conversion efficiency (recovery)

- ✓ Lumber recovery is influenced by a number of factors namely: taper, log characteristics, log properties, machinery, sawing patterns, labor skills and timber size.
- ✚ Taper: Amount of taper in the log has an effect on the potential timber recovery. Increased in log taper results in low recovery per cubic foot of log volume but higher recovery per board foot log scale. This effect of taper on recovery is less pronounced in larger log diameter.
- ✚ Log characteristics and quality: Lumber recovery also increases with decreasing log length and constant taper. Shorter logs reduce recovery loss due to taper and timber edging and trimming.
- ✚ In general terms log defects such as taper, swept crook, heart rot reduce lumber recovery because they lead to heavy slabbing and or edging and trimming and sometimes even rejection of the whole pieces.
- ✚ Machinery: There are no substantial differences in timber recovery between circular saw and frame saw. Band saw has higher recovery than the other two types because they cut with a narrow kerf. Accurate cutting and narrow kerf resulting from properly maintained machines may contribute significantly to improving lumber recovery.
- ✚ Sawing pattern: Modification of the two methods exist, In general live sawing results in higher timber recovery because it minimizes the volume converted into sawdust and since the log is turned only once, volume loss due slabbing is also minimized. In all sawing processes however , location of the slabbing or opening face of the log is the key to maximizing yield since it establishes the position of all other faces.
- ✚ The most advantageous method of sawing log depends on the market demand and prices differences between different grades and between thickness within grades.
- ✚ Labor skills: For machines to work properly they have to be operated and maintained by skilled personnel. Higher recovery from the operation of simple type sawmill is more dependent upon the skill of the sawyer than in the case of the more mechanized mills. This is because the operator is required to judge an optimal sawing of the log to maximize recovery.
- ✚ Timber size: In general the larger size of timber sawn the higher recovery. Cutting small lumber sizes involves too many sawn lines which lead to some loss through kerfs.

## Topic 4 : Timber conversion preliminary activities

- ✓ Timber decking: Is a way of adding/putting something to timbers (decoration) for making timbers look more attractive, beautiful, and decorative and become expensive. It is also traditional timber structure illustration by painting timber or by putting on them different colors.
  - ✚ Timber decking by structural wood system provides the beauty of timbers.
  - ✚ The most common timber decking are softwood and hardwood timber decking.
  - ✚ Many species of wood are suitable for decking but others are not.
- ✓ Timber edging: Is the way of edging the end of timbers formed by intersection of 2 surfaces such as the corner of a masonry unit, edge of a timber framing. Timber edging is done by using edgers.
- ✓ Timber trimming: It consists of cutting at the end of the surface of timber boards by removing an extra size according to the desired size of timbers. It is done by using trimmers which are in 3 types:
  - ✚ Double end trimmers
  - ✚ Multiple saw trimmers
  - ✚ Canadian saw trimmers
- ✓ First and second breakdown: The activity of removing the slabs on the log to saw for producing the flitches or cant is called first breakdown or primary breaking down.
  - ✚ The produced cant or flitches are marked into saw lines and then sawn into timbers of the standards length. This operation can be done by circular saw, gang saw and band saw.
  - ✚ In the second breakdown of timbers, the wane on the flitches is removed by edging, the cants are further sawn to smaller dimensions, the timber is trimmed to standard lengths and unacceptable defects are removed.
- ✓ Timber smoothing: Is an activity of flattening, truing surface and turning rough surface of timber into smooth surface by using different types of planners and electric sander.

Timber smoothing is used to produce horizontal, vertical or inclined flat surfaces on work pieces usually too large for shaping.

- ✚ Types of planes: Metal plane, wooden plane, smoothing plane, Infill plane and transitional plane
- ✓ Timber drying: Is a process of removing water from timbers. Timbers are dried by air or by kiln drying method.

This process reduces the weight of timber which results to decrease in costs of transportation, It increases the strength and decreases susceptibility to infection by the fungi and chances of being attacked by insects.

## **LO 2.4 – Transport timber to drying site**

### **Topic 1: Transport means**

There are different timber transportation, those are:

- ✓ Road transport way: is a way of transporting timber by using trucks, vehicles, lorries, rails or train, use the road to transport timber
- ✓ Aerial transport way: is a way of transport timbers by using airlines like helicopter, balloons and cables due to the time required is short, inaccessibility of the site and high amount of timbers to supply.
- ✓ Water or marine transport way: timbers are transported by using boats or ships in water paths. If land way is longer or not practicable.
- ✓ Manual transport: by using humans or labours where transport is held by over hand, on shoulder or on hand.

### **Topic 2: Loading and unloading methods**

There are manual loading and unloading and machinery loading and unloading.

- ✓ Manual loading and unloading method: Is a method of loading and unloading timbers by using the man power overhead or by hand.
- ✓ Machinery loading and unloading method: Is a way of loading and unloading by using different kind of machines.

## Learning Unit 3 – Preserve timber

Timber preservation includes every process of chemical or physical treatment which is undertaken to extend the life of timber in services by increasing its resistance to deterioration by biological, physical and chemical agents and mechanical wear.

Timber preservatives are chemicals substances which applied suitably to wood, make it resistant to fungus, insects or marine borers.

Timbers are preserved either by application of wood preservatives or by conditioning them.

### LO 3.1 – Dry timber

This is an operation of removing a big part of water from a timber and put it on the humidity degrees close to that hygroscopic equilibrium which correspond to utilization on conditions.

The moisture content of kiln dried timber piled under a good roof can increase by 1-2% per month to an upper limit 13-15% during humidity weather.

#### Topic 1: Determination of moisture content (Mc)

Moisture content of timber is defined as the weight of water in wood usually expressed as a percentage of the weight of oven dry wood.

The method of determining moisture content is the constant or oven dry weight whereas the weight of green specimen of timber and weight of the same specimen when is dry are used to determine the percentage of moisture content with the formula:

Formula: The mass (measured in grams or in kilograms) of water present can be determined from the difference in the mass of timber with water (initial mass) to the mass of timber with the water removed (oven dry mass). Hence the following equation is used to determine the moisture content of timber.




$$\%mc = \frac{\text{"mass of water present"}}{\text{"Oven dry mass"}} \times 100$$

$$= \frac{\text{"Initial mass - oven dry mass"}}{\text{"oven dry mass"}} \times 100 \text{ or } = \frac{\text{"Wet weight - Oven weight"}}{\text{Oven weight}} \times 100$$



## Topic 2: Site and atmospheric conditions

### ✓ Site organization

-  **Emplacement:** places where the timber are placed: they must have appropriate conditions with good aeration, good drainage, gentle slope, 1-2%, clean without weeds, slightly flat for avoiding deformations like bending.
-  **Confection of the pile:** This is a way of stacking the timbers in the built stack in order to protect them, avoid much time of drying, avoid decay, risks and wood loss.
-  **Bank or seat (stocking):** Determines the number or quantity of timbers per a given area. It indicates the capacity of receiving amount of timber in the store during drying which varies according to the size of store and size of timber.

### ✓ Atmospheric conditions:

The external drying conditions (temperature, relative humidity and air velocity) control the external boundary conditions for drying, and hence the drying rate, as well as affecting the rate of internal moisture movement. The drying rate is affected by external drying conditions. Those are temperature, humidity, rainfall, sunlight, season, rivers, wind and weather.

Knowledge of the temperature and relative humidity conditions is important, as they will dictate the lowest moisture content that can be achieved when drying wood out of doors. The temperature (of the sun and other source of energy) and relative humidity of the air varies from month to month and from region to region. The rate of drying and the equilibrium moisture content that can be achieved by air drying outside and rate of drying is governed by these conditions.

## Topic 3: Identification of drying methods selection

There are two main methods of timber drying in common use known as natural (air drying) timbers drying and artificial timbers drying (also known as kiln drying). Both methods require timbers to be stacked and separated to allow the full circulation of air around the stack.

The choice of drying method will be based on the following aspects:

- ✓ Timbers species
- ✓ Volume of timbers to be dried (quantity)
- ✓ Climatic conditions
- ✓ Business scale
- ✓ Means

## Topic 4: Identification of natural drying methods

### ✓ Natural drying or air drying meaning

This is a method of drying timber by exposing them to natural atmospheric conditions.

The timbers are dried in open air. As such there is no control over drying rate as this will be determined by the prevailing weather (temperature, relative humidity, rainfall and wind speed).

Some control over drying times and degrade can be achieved by correct stacking procedures of freshly sawn timber.

For this condition, timber losses the part of its water for achieving hygroscopic equilibrium varies from 10-30% according to the relative humidity of the place they are.

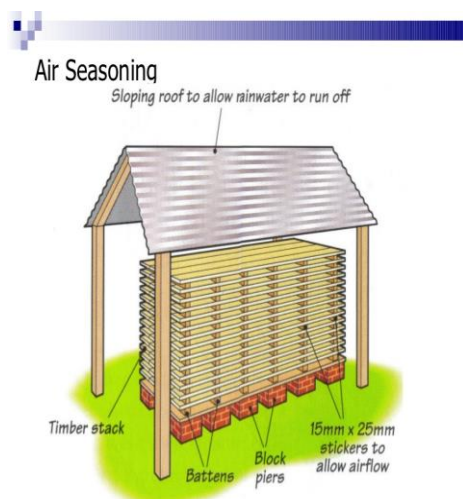
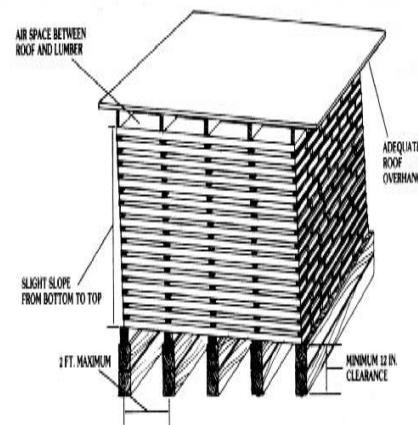


Figure 9: Air drying



## Topic 5: Identification of kiln drying methods

### ✓ Kiln drying or artificial drying meaning

Kiln seasoning is drying in a closed chamber, providing maximum control of air circulation, humidity and temperature. Air is circulated through stacks by fans. The fans are kept running at constant speed to maintain uniform flow. The principles of stacking are similar to those for air drying.

Under these conditions, drying is regulated and minimum shrinkage degrades and lower moisture content are achieved than is possible with air drying.

In kiln drying, high temperature and fast speed of air circulation are used to increase the drying rate.



Figure 10: Large wood-drying kiln

### ✓ Types of kiln drying

There are two types of kiln: Progressive kiln and compartment kiln.

#### ✚ Progressive kiln (continuous kiln or step kiln)

It is arranged so that green timbers enter one end of kiln and they are dried in progressive steps as they move to end where they are removed. This kiln type is suitable for timber of various species, size and age as timbers pass in many drying rooms and controlled drying conditions.

#### The activity of drying the timber requires:

- ❖ Forced air circulation by using large fans, blowers etc;
- ❖ Fuel burned to generate heat for drying timbers;
- ❖ Humidity control provided by steam jets.

✚ In progressive kiln, the temperature and humidity differentials are maintained throughout the length of kiln so that the timber load is progressively dried as they move from one end to another.

✚ Progressive kiln is subdivided into the following two types of kiln:

- ❖ Draft kiln (natural kiln): In this type of kiln heated air is allowed to pass through timbers stack by natural convection.
- ❖ Draft kiln (forced kiln): In this kiln type, fans are used to force or push air through timbers stack.

✚ Comparison between natural kiln and forced kiln.

Natural kiln	Forced kiln
Heated air passes through timber stack by natural convection	Fans are used to push heated air through timber stack
Greater drying period	Short time of drying
Expensive (in installation for ex.)	Cheap
Less wood defects	More wood defects in case of inattention

Table 8: Natural kiln and Forced kiln difference

## Compartmental kiln

Is a kiln made of a single enclosed container or rooms where timbers are stacked and seasoned to the moisture content require for use. To use this type of kiln the following aspects must be considered:

- ❖ Timber specie
- ❖ Initial moisture content
- ❖ Size of timber
- ❖ Age
- ❖ Heartwood and sapwood ratio.

## Other methods of wood seasoning are:

- ❖ Chemical seasoning
- ❖ Solvent seasoning
- ❖ Drying in boiling oil liquids or steaming
- ❖ Infra-red and vapor drying
- ❖ Electrical drying
- ❖ Vacuum drying

But, these methods consider the quantity, the value and time of require timbers.

## Topic 6: Advantages and disadvantages of air drying method

Advantages	Disadvantages
Low capital, cost, maintenance and requirements in terms of materials and labors	The drying time is long because the process depends on obtaining natural drying conditions (many months).
It is easy as compared to kiln method	This method takes more time than kiln method due to weather conditions.
It gives good results	It provide a dried product with less resistance
It is more economical to air dry timber to 25% to 30% moisture content if the material is likely to take more than 5 weeks	There is no control over the moisture content to which lumber is dried;
Less drying defects (cracking, bowing, splits etc)	
No special skills or training are necessary	
No steam, smoke, gases or other environmental irritants.	
It requires less control	

Table 9: Air drying

## Topic 7: Advantages and disadvantages of kiln drying method

Advantages	Disadvantages
It is rapid	It is expensive
Drying duration is shorter than air drying	It requires regular control
It provide a well dried timber of good quality and good appearance	It requires heavy foundation
It destroys all biodegradation agents that may have attacked timber	It requires skilled and experienced labor
Drying process is controlled (moisture content and temperature)	It may leads to some drying defects like splits, cracks etc
The process fumigates the timber	
It is the only way to condition timber for interior use	
It has high precision.	

Table 10: Kiln drying

## Topic 8: identification of drying time factors

Period of timber drying in drying site depends on the following factors:

- ✓ Kiln type
- ✓ Driers type
- ✓ Size of timbers
- ✓ Use tools and materials
- ✓ Used methods
- ✓ Specie
- ✓ Size of timber
- ✓ Initial moisture content: If the temperature is kept constant, lower relative humidity results in higher drying rates due to the increased moisture gradient in wood, resulting from the reduction of the moisture content in the surface layers when the relative humidity of air is reduced.
- ✓ Quantity of heat provided or Temperature: If the relative humidity is kept constant, the higher the temperature, the higher the drying rate. Temperature influences the drying rate by increasing the moisture holding capacity of the air, as well as by accelerating the diffusion rate of moisture through the wood.
- ✓ Skills and experience
- ✓ Air circulation rate: Drying time and timber quality depend on the air velocity and its uniform circulation. At a constant temperature and relative humidity, the highest possible drying rate is

obtained by rapid circulation of air across the surface of wood, giving rapid removal of moisture evaporating from the wood.

## Topic 9: Identification of drying defects

Drying defects which cause the degradation can be classified into 3 main groups:

- ✓ Those caused by unequal shrinkage examples: checks, collapse, honey combing, warping or twisting, bowing, checks, splits, shakes and shrinkage anisotropy like cupping, distortion and spring.
- ✚ Checks: Separation of fibers that does not extend through the timbers from one face to another face. This reduces the strength of timbers.
- ✚ Splits: Separation of fibers that extend through the timbers from one face to another face.
- ✚ Shakes: Separation of fibers in timber of large size. It can be star shakes (ruptures from the pith to the outside) and ring shakes (Ruptures that follow the growth rings).

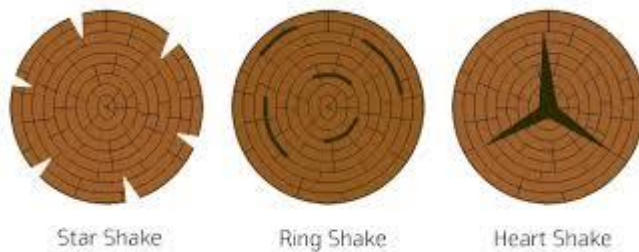


Figure 11: shakes defect

- ✚ Collapse: Is a defect of timber occurred in the early stage of drying when the free water leaves the cell. It affects timber appearance and ease application.

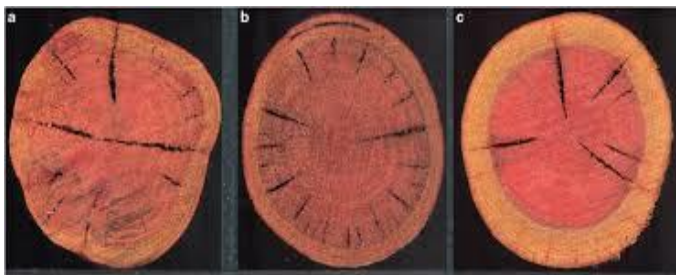


Figure 12: Collapse defect

- ✚ Cupping: Is a warp or curvature across the width of a piece of timber caused by more radial shrinkage than tangential.
- ✚ Bowing or bending: Deviation from the flat at the end. The piece of timber is archived.
- ✚ Twisting: is a spiral distortion of a piece of timber along the length of timber. It is caused by unequal shrinkage.

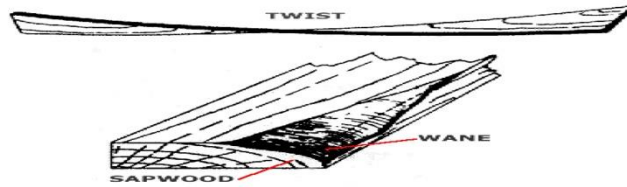


Figure 13: Twisting defect

- Spring: Is distortion in the longitudinal plane. The board remains flat due to interior stress when log is sawn through.
- Case hardening: The surface of timber dries faster than the core. These arise a tendency of the timber to shrink. Outer layer becomes stretched and inner layer compressed.

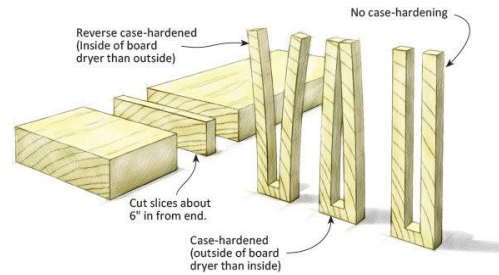


Figure 14: Case hardening defect

- Honey combing: Outer layer set without shrinkage, the normal amount, and when the interior dried below F.S.P. This reduces timber strength.

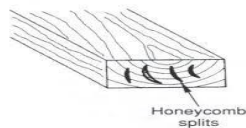


Figure 15: Honey combing defect

- Distortion: Is a defect caused by different shrinkage across the grains in radial and tangential.

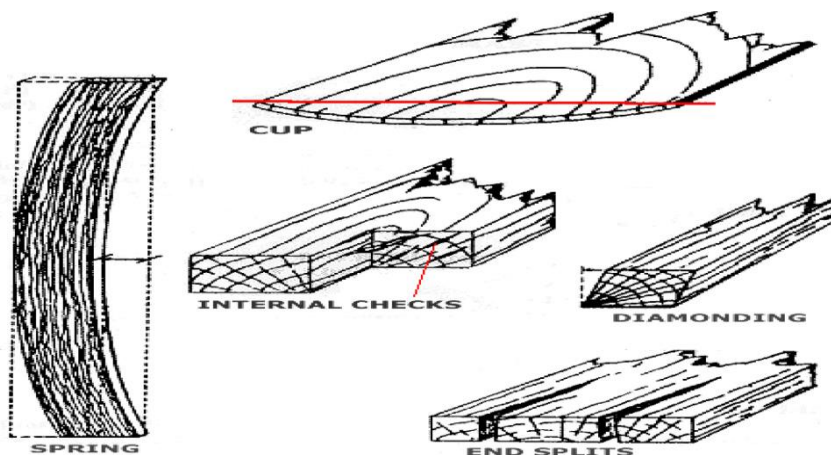


Figure 16: Spring, cup, splits and checks defects



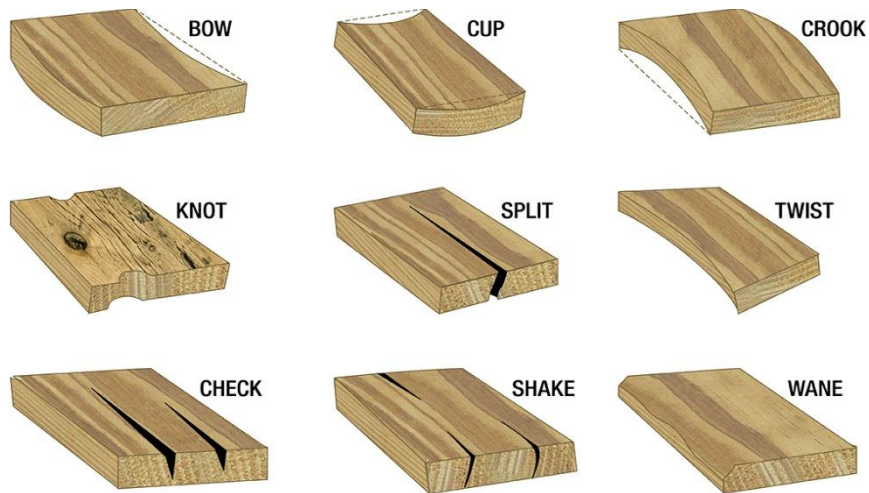


Figure 17: Different drying defects

- ✓ Those associated with the fungi action examples: mold, rot and stain. Those affect both appearance and strength.
- ✓ Those associated with soluble wood constituent examples: brown stain and sticker stain.

## Topic 10: Determination of prevention measures

- ✓ Strapping timber to avoid cupping defect
- ✓ Insecticide spraying before insect attack your timbers when they are being dried
- ✓ Correct stacking with uniform sticker spacing: Pile carefully with correct sticker spacing. Make sure stick thickness is uniform. Support the ends of all boards.
- ✓ Immediate timber drying
- ✓ Application of insecticide before insect attack your timbers when they are being dried
- ✓ Careful control on the uniformity of the thickness of the boards being cut can avoid or reduce distortion.
- ✓ Take timbers to driers immediately after they are sawn from logs.
- ✓ For star shake defects, you are advised to not expose the edge of timbers to heavy sunshine but covers them.
- ✓ Dry timber on optimum temperatures and moisture content
- ✓ Apply preservatives to timbers
- ✓ Good practice in timber drying



## LO 3.2 – Treat timber

### Topic 1 : Definition of timber treatment and enemies of timbers

- ✓ Timber treatment is a process of protecting or preserving timbers by using chemical substances called preservatives.
- ✓ Wood is susceptible or exposed to attack by biodegraders such as:
  - ✚ Fungus
  - ✚ Insects
  - ✚ Marine bores
  - ✚ Termites
- ✓ And other physical chemical agents such as:
  - ✚ Acid and
  - ✚ Fire

### Topic 2 : Identification of pre-treatment activities of timbers

Those are preconditioning of timbers activities carried out for preparing the timbers before treatment for ensuring effective treatment.

- ✓ Incising: It is a method of making small holes on the wood surfaces to allow chemical preservatives penetration.
- ✓ Steaming: Wood is treated by hot air that is applied on the wood until extractives are removed. Once all extractives are removed the wood is becoming soft so that preservative penetrate as deeper as possible.
- ✓ Cutting and framing: cutting, shaping or drilling timber after treatment which can expose untreated timber. This exposure can be avoided by cutting, shaping and boring.
- ✓ Debarking /peeling: bark and cambium must be completely removed before treatment for allowing to penetrate into the wood.
- ✓ Denting
- ✓ Drying/seasoning: for allowing better penetration of preservatives and reduce weight.
- ✓ Machining: For maximum protection it is highly desirable that all machining be completed before treatment otherwise if such machining is done after treatment, untreated wood will be exposed to biodegraders.
- ✓ Ponding: Putting the wood into the water or in the ponds.
- ✓ Steaming: Green timbers are steamed in a treating cylinder or retort for several hours and the subject to a vacuum.

- ✓ Compression: This is a way of make wood reactions.

### Topic 3 : Classification of timbers preservatives

Wood preservatives are commonly classified into the following categories:

- ✓ Tar oil preservatives;
- ✓ Organic solvent preservatives;
- ✓ Water born preservatives;
- ✓ Fire retardant preservatives

### Topic 4 : Identification of tar oil preservatives properties

- ✓ **Tar** refers to the substances obtained from a variety of organic materials through destructive distillation. Tar can be produced from coal, wood petroleum .Tar is made of cool tar (Peat, shale wood). It is made up of hydro carbons and hard to give its chemical composition and it contains:

- + Tar acids/ phenols, creosol etc.
- + Tar bases/ pyridine, quirolin etc
- + Natural oils/mixture of naphtelene and hydrocarbons

Example: creosote

- ✓ **Properties of tar oil preservatives**

- + They are resistant to leaching and are suitable for wood to be used in contact with the ground soil;
- + They are insoluble in water usually dissolved in petroleum or other organic solvents in order to penetrate wood;
- + Paintability, odour, appearance and combustibility of the treated wood are influenced by the residual oils.

- ✓ **Common oil borne used are:**

- + Coal tar creosote
- + Creosote mixtures
- + Pentachlorophenol
- + Copper naphtalenate in oil solution
- + Tributyl tin oxide (TBTO)










## Topic 5 : Properties of creosote preservative

- ✓ Creosote is a brownish – black oily liquid that comes from the tar produced during the carbonization
- Creosote is a brownish – black oily liquid that comes from the tar produced during the carbonization;
- ✓ It is highly toxic /effective to biological agents;
- ✓ It has the smell of rotten meat;
- ✓ Creosote is the oldest industrial wood preservative and is highly effective, insoluble in water and therefore when in wood, resistant to leaching;
- ✓ The preservative is not corrosive to metals, it protects timber against splitting and weathering and has high electrical resistance;
- ✓ They are available in several grades to suit various application methods;
- ✓ Treated timbers don't ignite easily and allow use of Aluminium based paint after 3 years in service.

## Topic 6 : Identification of water borne properties preservative

- ✓ Are the mixtures of salts and water. This includes various metallic salts and other compounds;
- ✓ They are based on salts, on copper or zinc together with metallic arsenates ,fluorides, bifluoride, chromium, arsenic and borates;
- ✓ Active ingredients are carried into the wood by water then after water evaporates leaving salts in the wood partially or fully fixed in the wood;
- ✓ Treated timbers with water borne solution must be dried after treatment
- Copper and zinc are fungicides while the rest are insecticide.

### Properties of water borne preservatives:

-  Are cheaper than oil based or tar oil preservatives;
-  Easy to prepare and effective to fungi;
-  Treated wood can be painted and chemicals don't create fire hazards;
-  Are less resistant to leaching and some are suited to ground contact use;
-  Are odorless;
-  Treated timber needs to be dried;
-  Treated timber prone to splitting;
-  Some serve as effective fire retardant when are applied in high concentration;
-  Can be applied in fresh wood by sap displacement.

✓ **Examples of water borne preservatives**

- ✚ CCA/ copper chrome arsenate
- ✚ Chromate copper arsenate
- ✚ ZCA/ Zinc chrome arsenate
- ✚ CCP/ copper chromate phosphate
- ✚ FCA/ Fluorides chrome arsenate
- ✚ CCB/ copper chromate borates
- ✚ CCF/ copper chromate fluorides

## **Topic 7: Properties of CCA**

- ✓ It cannot be leached once fixed in the wood;
- ✓ It is commercially available in different varieties;
- ✓ Effective against fungi and termites;
- ✓ Solution is colorless and non-corrosive to metal;
- ✓ Leave the surface of wood clear to handle.

## **Topic 8: Identification of organic solvent properties**

- ✓ Are active chemicals of either insecticides or /and fungicides are dissolved in organic solvents.

Example: Petroleum distillate

- ✓ Organic solvent properties:

- ✚ Are highly toxic;
  - ✚ They don't stain the wood;
  - ✚ High penetration therefore used for remedial services;
  - ✚ Insoluble in water, hence they are used for outdoor purposes;
  - ✚ Treated timber can easily be glued and painted.
- ✓ Examples of organic solvent preservatives
    - ✚ Lindane
    - ✚ Dieldrine
    - ✚ PCP
    - ✚ Copper naphthenate
    - ✚ Cu 8 quirolinate
    - ✚ Tri n butyltin oxide (used as pesticide/insecticide and fungicide)

#### Lindane

Lindane is the common name for  $\gamma$  isomer of hexachloro hexane and is used as an insecticide  $C_6H_6Cl_6$

#### Dieldrine

Dieldrine as other wood preservatives kills fungi and pests ( $C_{12}H_8Cl_6$ )

#### PCP (pentachlorophenol) $C_6HCl_5O$




It is used as pesticide and disinfectant (substances) applied on nonliving objects to destroy biodegradors

#### Copper naphthenate





Copper naphthenate provides protection against wood decay (fungicide) and water repellent qualities  
Naphthenate treatment s results in wood that is clear to the touch and with minimal excess preservatives in contact with environment.

### Topic 9 : Properties of PCP, CU 8 quinolate, dieldrine, lindane, tri-n-butiltin






#### ✓ Properties of PCP

-  Toxic to fungi;
-  Insoluble in water;
-  Non volatile and not corrosive to metals.

#### ✓ Properties of cu 8 quinolate

-  Do not stain the wood;
-  No corrosive to metal;
-  Does not cause swelling in the wood;
-  But this chemical products is flammable

#### ✓ Properties of Lindane and Diedrine

-  It is an excellent fungicide;
-  More effective than PCP;
-  Insoluble in water;
-  No corrosive to metal;
-  But not very toxic to termites.

#### ✓ Properties tri n butyltin

-  An effective fungicide;

- ✚ Effective than PCP;
- ✚ Insoluble in water;
- ✚ less toxic to human being than Lindane;
- ✚ But it is more expensive.

## Topic 10 : Identification of fire retardant preservative

Fire retardant preservatives include 2 general methods that are available for decreasing the flammability of timber by using the fire retardant chemicals.

One method consists of impregnating the timber with water borne salts, the other involves applying fire retardant –paints coating to the timber surface.

### ✚ Impregnation with water borne

It absorbed in the zones into which previously the pasty preservatives had been introduced.

Complete impregnation of the timber is necessary to obtain classification by some codes as being noncombustible. However to reduce the surface flammability of thicker members partial impregnation is more common.

The salts used in the current fire retardant are principally mono-ammonium, diammonium phosphate, ammonium sulfate, zinc chloride, borax and boric acid.

### ✚ Paint-coating: An alternative method of protecting timber from fire involves applying fire retardant chemical paint coating to the timber surface.

The major advantage is to reduce the spread of flames. For timbers in construction, coating method offers a principal means for fire protection.

Fire retardant paints include: water soluble silicates, Urea resins, Carbohydrates alginate, polyvinyl emulsion, oil base, alkyd and pigmented type.

Most Fire retardants coating are intended for interior use.

## Topic 11: Properties of ideal timber preservative

The followings are characteristics of ideal wood preservatives:

- ✚ Toxicity: should be toxic to degraders;
- ✚ Penetration: give deep penetration;
- ✚ Safety: harmless to man, animals etc;
- ✚ Not corrosive: to metals and other materials;
- ✚ Permanence: remain in the wood long enough and resist from leaching;
- ✚ Cost: should be affordable and available on the market;
- ✚ Odor/smell: no unpleasant smell or odor;
- ✚ Color: do not affect the final color of treated wood;
- ✚ Water repellency: must be water repellent it means does not dissolve in water.

## Topic 12: Advantages and disadvantages of oil borne preservative

### Oil borne preservatives

Advantages	Disadvantages
Not corrosive to metal	It has a pungent smell (affecting organs)
Toxic to biological agents	Bulky to transport
Low solubility	when wet its oily and not easily to handle
Easy handling and use	Not very effective to termites hence needs to fortify
Can be dissolved in oils	Evaporation of volatile matter occurs hence the hydrocarbons are leached out and bacterial attack follows.
	Can leave on oily, unpaintable surface depending on carrier
	They should not be used in homes or other living areas because of toxic fumes
	Strong odor is toxic and irritating to plants, animals and humans

Table 11: Advantages and disadvantages of oil borne preservatives

## Topic 13: Advantages and disadvantages of water borne preservative

### Water borne preservatives

Advantages	Disadvantages
Is leach resistant	Is prone to splitting
Used and gained for timber, fences, posts, poles, piling and plywood	It does not protect the wood from excessive weathering
The wood surface is left clean, paintable and free of objectionable odors	Unless redried after treatment, timber is subject to warping and checking
Treatment presents no hazard from fire or explosion	

Table 12: Advantages and disadvantages of water borne preservatives



## Topic 14: Advantages and disadvantages of organic preservative

### Organic solvent preservatives

Advantages	Disadvantages
-Leave the surface of wood clean to handle	-Are very expensive in relation to water borne solvent
-Not bulky hence easy to transport in paste form and formulated at the treatment site	-Treated wood can be ignite easily
-They don't stain the wood	
-High penetration therefore used for remedial services	








Table 13: Advantages and disadvantages of organic solvent

## Topic 15: Advantages and disadvantages of fire retardant preservative

Advantages	Disadvantages
Resist to fire	Expensive
Resist to weather conditions	Not locally available

Table 14: Advantages and disadvantages of fire retardant

## Topic 16: Identification of non-pressure preservatives application methods

-  These are methods where no external pressure is applied to force the preservative to flow into the wood. It does not require vessels. Deep penetration, high levels of retention and precise treatment are not required.
-  Non pressure methods of preservative treatment include, brushing and spraying, immersion, diffusion, dipping, steeping, cold soaking, vacuum process.
-  Brushing/ flooding the surface of timber using a simple brush.
-  Spraying/ flooding the surface using simple sprayers applicable to timber in service.
-  Deluging/ mechanized treatment using sprayers.
-  Cold soaking: Consists of soaking dried timbers for 2-7 days in a vat containing unheated liquid oil preservatives.
-  Hot and cold treatment: Also called boiling or cooling or open tank treatment. Is one of the more effective processes. The timber is heated in preservative (Oil or Water).

- ✚ Diffusion: Is a method of dispersing of a liquid preservative into a piece of timber or immersing of timber in a sodium arsenate or a sodium chromate.
- ✚ Immersion (steeping and dipping):
- ✚ Steeping: Consists of submerging the timber in a tank full of preservative solution for several days or weeks. Absorption is rapid the 3 first days then continues at decreasing rate almost indefinitely.
- ✚ Dipping: Consists of immersing the timber in a tank full of preservative solution for several seconds, min or hours. The 3 first days then continues at decreasing rate almost indefinitely.

## Topic 17: Identification of pressure preservatives application methods

- ✓ Is carried out in enclosed cylinder or retort where there is required supply of pressure to force preservatives into the timber cells.
  - ✓ In this method wood and preservative are put in cylinder and a specific pressure is introduced inside to facilitate efficient penetration of preservation of preservative in the wood. Duration is about 2 hours with pressure of  $1.03.10\text{n/m}^2$ . After these the cylinder is opened to take out preserved wood.
  - ✓ Pressure process includes: Full cell process, empty cell process and double vacuum.
- ✚ Full cell process: Used with water borne or oil preservatives where high retention is required. The period varies with the desired gross absorption. Dried timber is placed in the treating cylinder and a vacuum drawn. The cylinder is the filled with preservatives heated if necessary and pressure is applied up to  $100\text{-}200\text{ib/inch}^2$ .
  - ✚ Double vacuum process: there is simple variation of the full cell process and used for the controlled application of light organic solvent preservatives to building and joinery timbers.
  - ✚ Empty cell process (Lowry) is the similar to the full cell process but without a preliminary vacuum. Retention is less than with the full cell.
  - ✚ Empty cell process (Rueping): requires initial air pressure instead of an initial. The initial air is trapped in the timber and expands where pressure is released forcing out a considerable amount of injected liquid. The process is used when low retention is specified. Empty cell process requires that timbers are placed in an impregnation cylinder.

## LO 3.3 – Store timbers

### Topic 1: Timber stacking criteria

- ✓ Timber stacking is a process of making stack of timbers. Good quality packs are needed to build stable stack. Packing the same type of timbers together to remove internal air space and using suitable sticks to bind layers of timbers will improve pack stability. Stacks should not be allowed to lean on each other. Stacks with a height to base ratio of 4:1 will remain stable. Further stacking 2-4 layers is best. Only place the wedges during stacking if timbers seen unstably.
- ✓ Stacking criteria are mainly based on the following factors:
  - ✚ Species
  - ✚ Dimension/size
  - ✚ Moisture content (Mc)
  - ✚ Market

### Topic 2 :Timber grading criteria

- ✓ Timber grading is a process by which timbers are sorted into groups with ideally, similar appearance or structural properties in each group. Timbers are sorted into 3 groups:
  - ✚ Group A: Is the highest quality used for top class joinery and exposed chopping. It is subdivided into A1-A4.
  - ✚ Group B: Is the most common grade in construction.
  - ✚ Group C: Is used in area such as packaging.

Timbers are specified by its grade so it is important to understand the term used in grading and the characteristics of each grade.

- ✓ Grading criteria/ factors:

Timber grading is done based on both appearance and strength factors. The grader marks each piece of lumber according to such factors as:

- ✚ Size of timbers
- ✚ Quality of timbers
- ✚ Mc
- ✚ End use

### Topic 3: Timber labelling information

- ✓ Timber labelling is a process of putting on timbers the labels which gives information about the stored timbers. It is an important as protecting them from harsh elements. It helps to identify information relevant to the handling and development of each piece as what type of timber it is and how long it has been stored.
- ✓ On the label the following information are given:
  - ✚ Treatment date
  - ✚ Species
  - ✚ Origin
  - ✚ Butch number
  - ✚ Company name

## Topic 4: Timber storage conditions

- ✓ Timber storage is a technique of putting timbers in the appropriate condition of a store.
- ✓ Timber storage can be classified into five major types: outdoors, open shed, closed and unheated shed, closed and heated shed, and conditioned shed. The desirable type of storage depends on the moisture content of the lumber and the weather conditions during storage.
- ✚ Temperature: The temperature in the store must not be at a minimum or at a maximum level for avoiding damages of stored timbers.
- ✚ Dry place and cool place
- ✚ Aeration: Store should be adequate room space for good air circulation around the stacks.
- ✚ Hygiene: Store should have good hygiene as well as cleaned and swept.
- ✚ Free from pests: Timbers should be stored in a store free from insects, fungus, mold and rodents and should be stored in the treated store by pesticides or fungicides spraying.
- ✚ Clean a place and shade place

## Topic 5: Timber store management

- ✓ Timber storage is a fundamental consideration when it comes to timber. It has a dramatic effect on its appearance, performance and value. Firstly, it is important to manage temperature and humidity levels. If there is difference between the moisture content of the wood and the moisture content of your storage area, the timber may shrink or warp.
- ✓ Management of stored timbers consists to aerate the stack of timber for close shed, sealing for open shed and ventilation for those partially dried timber for effective drying.
- ✚ LIFO for Last –in, First-out

It is a method used for cost flow assumption purposes in the cost of goods sold calculation.

It assumes that the most recent products added to a company's inventory have been sold first. The costs paid for those recent products are the ones used in the calculation.

The LIFO method is used in the costs of goods sold calculation when the costs of producing a product or acquiring inventory has been increasing.

- ✚ FIFO stands for First-in, First –out.

It is a method used for cost flow assumption purposes in the cost of goods sold calculation. It assumes that the oldest products in a company's inventory have been sold first. The cost paid for those oldest products are the ones used in the calculation.

FIFO storage method assumes goods of your company acquired first are sold, used or disposed of first or the first purchases are the first sales.

### **The difference between LIFO and FIFO**

LIFO goes on the assumption that the most recent products in a company's inventory have been sold first and uses those costs in the cost of goods sold calculation.

FIFO method does the opposite. It assumes that the oldest products in a company's inventory have been sold first and uses those lower cost numbers instead.

## **Topic 6: Advantages and disadvantages of LIFO and FIFO**

FIFO method does the opposite. It assumes that the oldest products in a company's inventory have been sold first and uses those lower cost numbers instead

### ✓ **Advantages and disadvantages of LIFO**

Advantages	Disadvantages
LIFO maximizes profits during periods of deflation	LIFO is more difficult to maintain than FIFO because it can result in older inventory never being shipped or sold
When using the LIFO method, the cost of goods sold figure includes the latest costs of your inventory, which reflects the market more accurately than if you were using older costs.	LIFO also results in more complex records and accounting practices because the unsold inventory costs do not leave the accounting system
LIFO is also argued to be a more accurate reflection of profits. when prices generally rise over time, and this is known as inflation .	LIFO is not recommended if you have perishable products, since they may expire on the shelf before they are sold or shipped
	LIFO also is not an ideal method for businesses expanding globally because a number of international accounting standards do not allow LIFO valuation.
	During times of inflation, LIFO results in a higher cost of

	<p>goods sold and a lower balance of remaining inventory.</p> <p>A higher cost of goods sold means lower net income, which results in a smaller tax liability.</p>
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*Table 15: Advantages and disadvantages of LIFO*

✓ **Advantages and disadvantages of FIFO**

Advantages	Disadvantages
During periods of inflation, FIFO maximizes profits as older, cheaper inventory is used as <b>cost</b> of goods sold	it appear as though your company has a greater cash flow than it does
include its ease of application and its acknowledgement of the fact that companies cannot manipulate income by choosing which unit to ship	This larger-than-life profit, of course, leads to a heavier tax burden if FIFO is used during periods of inflation
The method is easy to understand, universally accepted and trusted.	Higher taxes from FIFO valuation diminish a company's cash flows and growth opportunities.
Many businesses have inventory which has a time limit on its sale, and so FIFO matches the reality of selling one's oldest goods first.	FIFO is typically fails to show an accurate picture of costs when material prices increase rapidly.
When you use FIFO, the goods most recently purchased or manufactured by your business are reflected in your balance sheet, which reflects the most up-to-date market pricing and means more accurate reporting	

*Table 16 Advantages and disadvantages of FIFO*



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