TVET CERTIFICATE III in CARPENTRY

MATERIALS AND HAND TOOLS

CAPMH301

Use wood working materials and hand tools

Competence

Credits: 9

Learning hours: 90

Sector: Construction

Sub-sector: Carpentry

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Purpose statement

This module describes knowledge and skills required to use wood working materials and hand tools. It describes the skills, knowledge and attitudes required for the trainee to identify classes of timbers and use hand tools.

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Learning Unit 1 – Identify classes of timbers

Introduction to timbers

Timber, also known as lumber in North American English, is a type of wood that has been processed into beams and planks, a stage in the process of wood production.

Timbers are classified by the following characteristics:

a) **Grain characteristics**: Grain is the size arrangement of wood poles or fibers and cells.

The grain size can be fine or coarse.

b) **Smell:** Each type of timber has a distinct smell some have sweet or aromatic smell.
c) **Color:** Timber can also be identified by their colour
E.g: Mvule is dark brown, ….

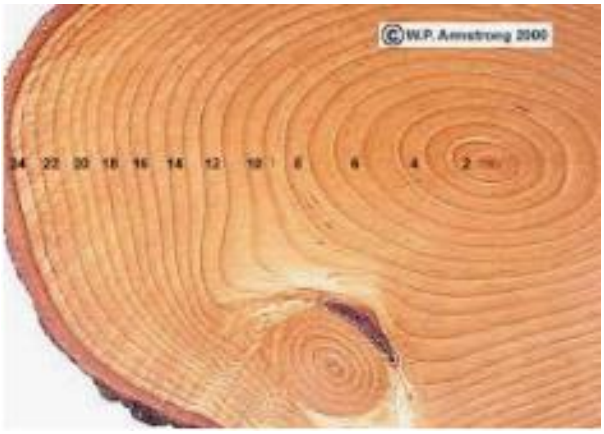
A tree: According to the carpenter, a tree is a big plant that can live for a long time and produce timbers.

Trees have a central part called a TRUNK/STEM or bole and many smaller parts called branches.

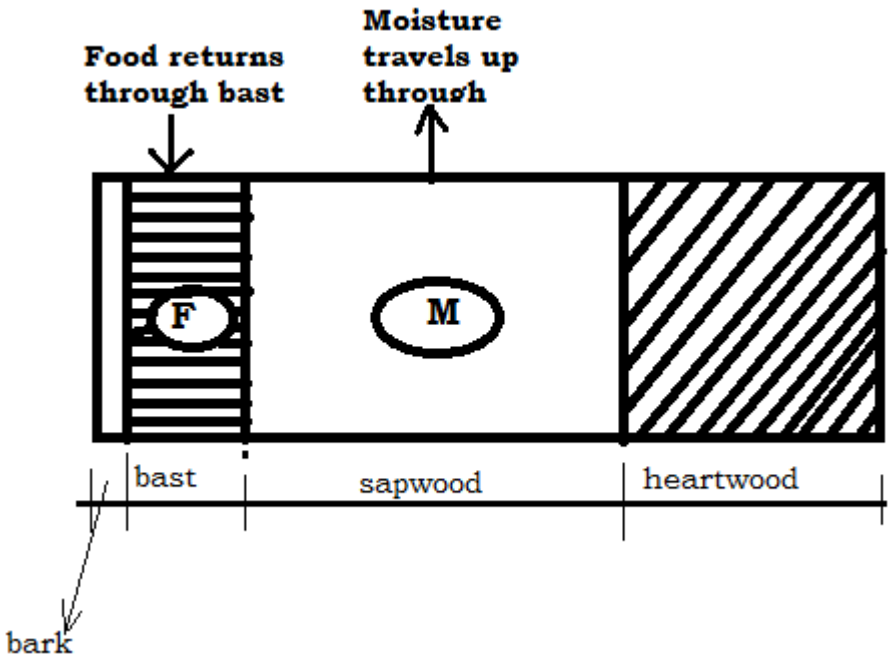
Ex: Oak, Pine, Cedar, African mahogany…

How a tree grows?

A tree grows outward from the center by adding new cells, or fibers, around itself including trunk, branches and roots.



A tree absorbs moisture and nutrients from the ground through its roots. This material rises to the leaves where it is converted by photosynthesis to sap, which is the growth material of the tree.



The growth of a tree is affected by the **soil** and the **climate** in which it grows. Soil has a considerable effect on the texture of timber, while climate influences the rate of growth which, in turn, affects the uses to which the timber can be put.

Fast grown softwoods, for instance, are weaker and less suitable for use where strength is required.

Main parts of a tree

In general tree has 3 main parts

- Roots
- Trunk/stem
- Crown

Roots

Roots is a part of a tree /plant that is under the ground. Roots are very important parts of a tree because are the way of the food from the soil up to the leaves.

Roots have 2 main roles:

- ✓ To feed a tree (absorb water and mineral from the soil).
- ✓ To fix a tree in the soil.

Trunk/stem

It supports tree and channels nutrients to and from roots. Trunk is a part of a tree which is important especially on the carpenter.

Because it is where we get timbers. According to the tree life it join roots and crown.

Crown

Crown is a part of a tree, it contains:

-Branches

-Leaves

-Grains

-Flowers

It is also very important especially on the tree life well understood the photosynthesis because of the sun and chlorophyll from the leaves.

The food is distributed to all parts of a tree by means of small cells which are called **rays.**

These rays are more noticeable in the hardwoods than in softwoods, where they would usually only be seen through a microscope. Each time this cycle is completed the tree gains one more growth ring (also called an annual rings).

It is by counting these rings that the age of a tree can be determined, as each ring represents one year of growth.

Trees classification

Trees are classified into two main classes:

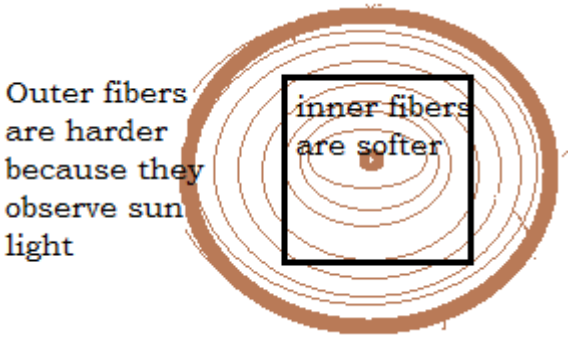
- Endogenous trees
- Exogenous trees

Endogenous trees

It is a class of trees which produce fibers and hollows in their trunks or stem.

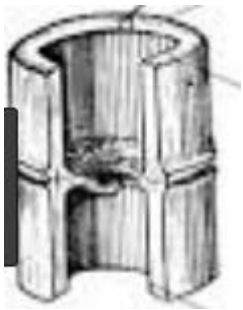
EX: Trees producing fibers in their trunks

- ✓ Coconut tree
- ✓ Palm tree
- ✓ Paw paw tree
- ✓ Sugar cane tree
- ✓ Maize tree
- ✓ Elephant grass
- ✓ Millet tree



Trees producing fibers and hollows in their trunks

Bamboos trees



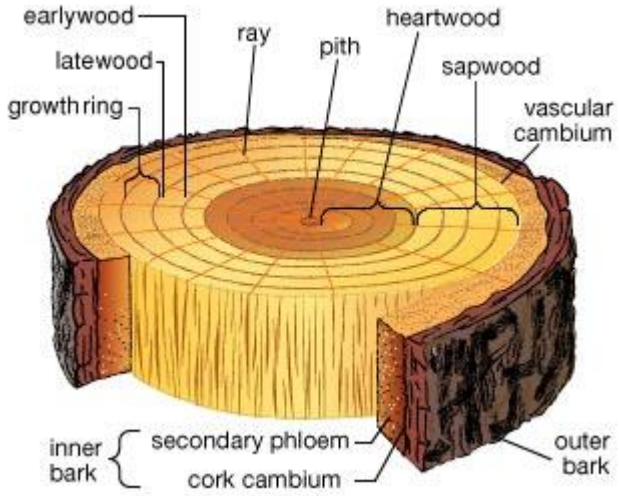
Exogenous trees

It is a class of trees which produces annual or growth rings in its trunks or stem.

This class is also divided into 2 groups.

- **Hard wood**
- **Soft wood**

Inner log structure of a tree



LO 1.1 – Identify types of timbers

- Content/Topic 1 Types of timbers

As stated above, trees produce timbers that are subdivided into 2 groups:

- **Soft woods**
- **Hard woods**

1. **SOFTWOODS**

✓ Are pieces or wood that have needle like or pin like leaves and are generally evergreen.
✓ This type of timber is produced from trees that **do not lose** their leaves (coniferous).

- ✓ Softwood trees grow much **quicker** than the hardwood ones
- ✓ They are therefore **cheaper** to buy and far more available
- ✓ Softwood is used for construction of **houses** and **furniture,** and outdoor uses such as **fencing**
- ✓ They have an open grained texture, which is easy to work on than hardwood.
- ✓ They can grow in plantation to provide a continuous supply of timber.
- ✓ They have a light color than hard wood.
- ✓ They need to be protected from insect attack
- ✓ The timber they provide need to be protected from weather by paint, varnish or preservatives.

The term softwood does **not** mean that the timber is soft, as pitch pine is one of the most difficult timbers to work with, and yet is a member of this group.

2. HARD WOODS

- ✓ This type of timber is produced from **broad leaf trees**
- ✓ They **lose their leaves in winter** – a deciduous tree.
- ✓ Hardwood is used to make expensive furniture/flooring and strong framed structures.
- ✓ **T**hey are reddish in color, always looks good when varnished or waxed.
- ✓ They have close grain makes it very suitable for kitchen utensils, as water does not have too great an effect on it.
- ✓ They are selected for their good decorative appearance.
- ✓ They are usually left undecorated except for varnish or paint.
- ✓ They are slow in growing.
- ✓ They are harder to work with hand tools than soft woods.

The term hardwood does not mean that the timber is **hard**. For example balsa is used for modelling, it is a hard wood but it is one of the softest timbers to work with.

LO 1.2 – Use methods of seasoning timber

- Content/Topic 1 Timber seasoning and storing methods

a) Properties of wood

-Physical properties

-Chemical properties

-Physical properties

Two of most important physical properties that affect the strength and durability of clear wood are:

- Moisture content (MC)
- Specific gravity

Timber cut from juvenile logs has the potential to be markedly low in strength and stiffness compared to timber from mature trees, the magnitude of reduction varying between species.

- **Moisture content (MC)**

It is the weight of water in wood as percentage of its oven dry weight.

MC= $\frac{Weight\ of\ Water}{Oven\ dry\ weight} x100$ or

MC= $\frac{Wet\ weight\ of\ sample - Dry\ weight\ of\ sample}{Dry\ weight\ of\ sample} x100$

Example: If a 150 grams of a sample weight become 100 grams after drying. Calculate its moisture content.

ANSWER: MC= $\frac{150-100}{100} x100 = \frac{50}{100} x100$=50%

- **Specific gravity**

This is the relationship between the density of wood and the density of water.

The weight of wood depends on

-The species

-Growth of the tree moisture content

-The part of the log.

Green wood (or freshly cut timber) is heavier than dry wood; green sapwood is heavier than green heartwood; whereas dry heartwood is heavier than dry sapwood.

The density of wood is defined as the mass or weight per unit volume.

£= $\frac{m}{v}$

Whereas: £= Density
m= mass
v=volume

Both density and volume of wood vary with the moisture content and thus the two closely related physical properties of wood.

For calculating the wood specific gravity, they use total density of wood over the density the density of water.

Sp.G(Δ) $= \frac{\text{£ of material}}{\text{£ of water}}$ or

Sp.G(Δ)$= \frac{\text{mass of material}}{\text{volume of material x £ of water}}$

CHEMICAL PROPERTIES OF WOOD

The solid part of wood is chiefly cellulose which is composed of different chemical composition.

A tree as other beings is made (composed) of **carbon**, **hydrogen** and **oxygen**.

In addition, other substance such as minerals, sugars, resins, oils, gums, etc are found in wood. Altogether, wood is approximately **50% carbon**, **6% hydrogen** and **44% oxygen**.

FELLING AND CONVERSION OF TIMBERS

Felling is the process of cutting down individual trees, an element of the task of logging. The person cutting the trees is a *feller*.

In hand felling, an axe, saw, or chainsaw is used to *fell* a tree.

Timber form building purposes should be from trees which are felled as soon as they have reached their maturity because if cut prematurity, the wood will not be durable and will contain much sapwood and the trees which evergreen will produce timber which is brittle and may show the sign of decay.

Trees should be felled when they have just matured or are maturing. Trees in immature condition:

a. Are not durable as the heartwood and sapwood are green
b. Attract insects as the sap is in excess
c. Are an economical to cut In mature trees:
d. Heartwood starts decaying
e. Tree is liable to develop shakes and cracks due to drying up of the sap

What is conversion of timber?

The process of cutting logs into timber is called conversion.

There are several methods of conversion, each of which has some special advantage. For some timbers conversion must take place before the log has time to dry out and shrink.

The wood is often used to describe timber either a collection of growing trees. While timber is a wood in the form of square boards or planks.

Initial conversion may be carried out in the forest whilst the log is in its green (freshly felled) state This leads to a reduction in transport cost, as squared sectional timber can be transported more economically than logs.

What are some of the factors that determine the type of cut?

The way the cuts are made will depend on several factors, some of which are:

- The type of sawing machine
- The condition of the log
- Economy
- The size of log
- The wood species
- The end use of resulting timber

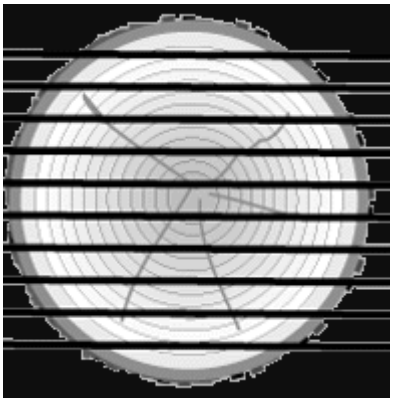
Methods of conversion of timber

There are three main methods of conversion of timber. They are:

- Plain sawn
- Quarter sawn
- Rift sawn

Plain sawn

- Plain sawn which is sometimes called **through-and-through** or slash sawing. In plain sawing, the saw cut forms a tangent to one of the annual rings. There are several variations of plain sawing



Advantages of plain sawn

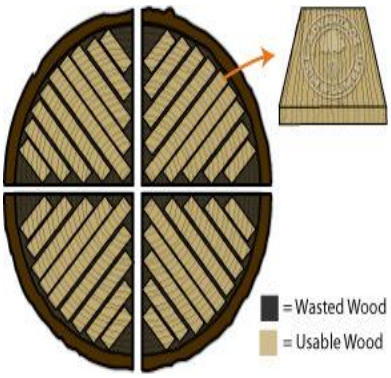
- There is no waste of timber.
- It is a cheaper method
- Easiest and economical method

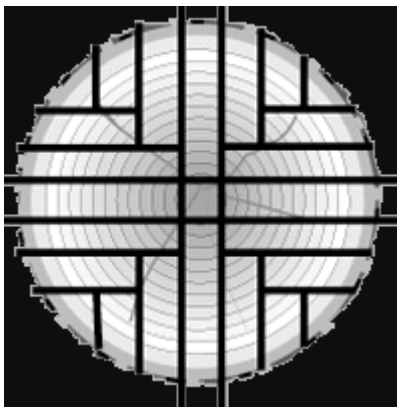
Disadvantage of plain sawn

- It has the disadvantage that shrinkage may tend to warp and split the boards.
- They also tend to absorb more moisture from the air which can also lead to unwanted movement

QUARTER SAWING

- Quarter sawn lumber comes at a premium due to the labor it takes to mill each plank. To mill quarter sawn wood, each log is sawed at a radial angle into four quarters. Then each quarter is plain sawn. This method of quarter sawing does leave some waste, but much less than rift sawn lumber.



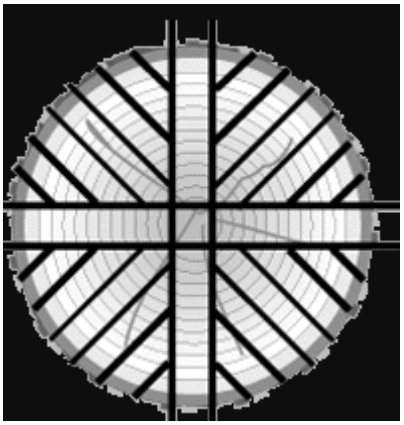


Advantages of Quarter Sawn

- Decreased expansion and contraction on the plank's width
- Twisting, cupping, and warping resistance

Disadvantage of Quarter Sawn

- The cutting operation is much more complicated and involves more waste.
- The boards are rather narrow.
- It is an expensive method



Milling rift sawn lumber takes more time and labor. It also has unique benefits over quarter and plain sawn lumber. Furniture makers depend on this cut of wood for the vertical grain that is shown from all sides.

Advantages of Rift Sawn

- Ideal for custom furniture makers to use for table, chair and other straight pieces
- The most dimensionally stable cut of lumber available
- Unique, linear appearance on both sides of the lumber planks
- Rift sawn lumber is dimensionally superior to both plain sawn and quarter sawn lumber.

Disadvantage of Rift Sawn

- They also produce the most waste.
- Rift sawn lumber will cost more per board foot than both quarter sawn and plain sawn lumber.

Why is it important to have allowance cut the logs into timber?

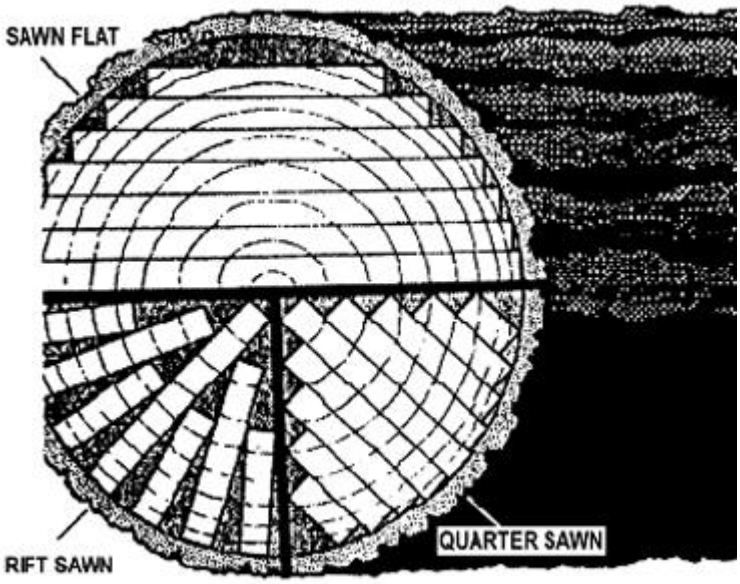
When sawing, an allowance is made for shrinkage and for planing the boards to the required finished sizes.

RIFT OR RADIAL SAWING

- Timber cut parallel to medullar rays and perpendicular to annual rings

►least shrinkage but most wasted
►limited rift is adopted

Greater decorative effect ►medullar rays pronounced



TANGENTIAL SAWING

- Boards or planks sawn tangentially to annual rings
- Not suitable for flooring

Planks cut by this method warp too much

SEASONING OF TIMBER

As fresh timber which is obtained from trees contains about 30 to 40 % sap or moisture. This sap is very harmful for the life of a timber. Therefore, it is necessary to remove that sap by applying some special methods. All those methods which are used for removing the sap from timber are collectively termed as seasoning of timber.

Seasoning: Wood drying/ seasoning lumber reduces the moisture content of wood before its use. When the drying is done in a kiln, the product is known as **kiln-dried** timber, whereas air drying is the more traditional method.

- **Methods of seasoning and storing:**
  - **Natural seasoning**
  - **Artificial/kiln seasoning**

- **Artificial seasoning**

In kiln seasoning timber is placed in a chamber with some special heating arrangement. In this process one thing should be kept in mind that heating system should be under control, otherwise timber will be crack or wrap. The time required for this seasoning is 3 to 12 days. This is quick process.

Advantages:

1. Seasoning can be done thoroughly well and in the shortest time under controlled process. And it is predictable so that dry timber inventories can often be reduced.

2. The wood can be used immediately as and when required.

3. It renders the timber less liable to be attacked by insects and fungi and shrinkage.

4. The moisture content can be reduced as per the requirement.

Disadvantages:

1. It is a costlier method though space required is less.

2. Skilled labor is required.

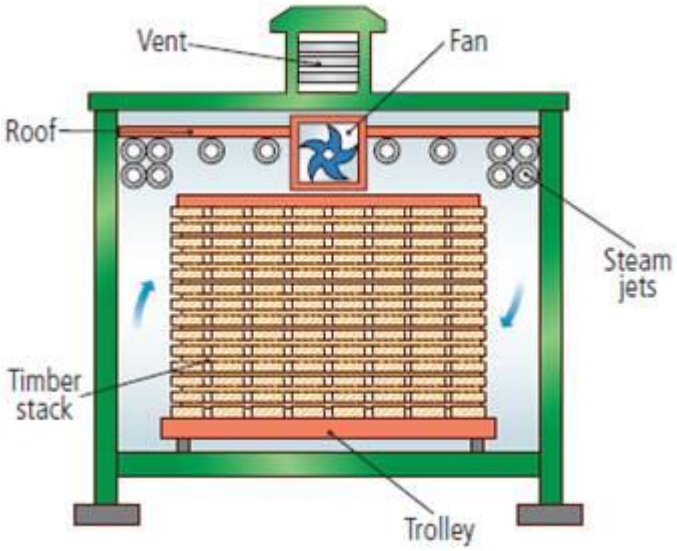
3. Being a quick process of drying, a continuous attention is required.

4. Also steam more or less weakens the strength and elasticity of timber.

Amount and Duration of **Air**, **Heat** and **Humidity** depends upon:

1. Species
2. Size

3. Quantity



Timbers stacked inside the Kiln

Timber does not dry to a state of zero moisture content, unless placed in an oven kept at a temperature above the boiling point of water. Timber in use will be exposed to air, which always contains some moisture. The quantity of moisture in air is a measure of its humidity. The moisture content of timber in service depends on the relative humidity of the air surrounding it. As the humidity rises and falls, so does the moisture content of timber

Spacing of strips

For drying straight-grained timber, the strips can be placed at 450 mm centers.

- **Natural seasoning**

In the air seasoning or natural seasoning or natural drying, seasoning of timber, timber is dried by direct action of air, wind and sun. In this method, the timber logs are arranged one over the other, keeping some space or distance between them for air circulation of fresh air. Generally this type of seasoning requires few months to over a year, this is very slow process.

Advantages:

1. It is a simple and economical method.

2. It does not requires much skill and attention in the process of seasoning.

3. Being the slow process, the chances of seasoning defects in the timber are comparatively less.

Disadvantages:

1. It is a very slow process.

2. The moisture content cannot be reduced less than 15 to 18 percent.

3. It can be easily attacked by insects and fungi due to long period of seasoning even under favorable conditions.

4. The space required for staking timber is large.

In addition to the above advantages of drying timber, the following points are also significant:

1. Dried timber is lighter, and the transportation and handling costs are reduced.
2. Dried timber is stronger than green timber in most strength properties.
3. Timbers to be preserved have to be properly dried if proper penetration is to be accomplished, particularly in the case of oil-type preservatives.
4. In the field of chemical modification of wood and wood products, the material should be dried to a certain moisture content for the appropriate reactions to occur.
5. Dry wood generally works, machines, finishes and glues better than green timber (although there are exceptions; for instance, green wood is often easier to turn than dry wood). Paints and finishes last longer on dry timber.
6. The electrical and thermal insulation properties of wood are improved by drying.
7. To ensure any shrinkage that can take place before timber is used.
8. To minimize the moisture content up to the safety line.
9. It has reduced weight,
10. It has resistance to decay or rot,
11. It is easier to work,
12. Its life is more.

How to Store Timber Safely.

Timber is a natural material that is susceptible to damage more than even plastic or metal. Failing to store timber supplies properly results in cost spikes on a building project. When the supplies spoil, financial penalties and delays may be incurred when seeking for the delivery of replacements.

The Common Problems

Storing **timber** the right way is vital for a variety of reasons, meaning you need to make the right storage efforts at the preparation stage. If the supplies spoil, you will incur costly delays. All you need is a storage plan. The most common issues faced when timber is not stored correctly include and not limited to:

- Decay
- Split
- Shrinking or expansion resulting from the wood's moisture content.
- Discolouration

Keep It Clean and Dry

Your timber supplies must be stored in a well-ventilated area for proper air circulation. Outdoor space such as sheds, warehouses, and garages are ideal. The circulation should keep the supplies dry and clean. Your

deliveries need to be timed appropriately to prevent the exposure of your timber to the elements. The delivery should be scheduled to fit the phase of the project it is required for. Inspect the signs of damage and warping on delivery.

Avoid Storing in New Buildings

Do not make the mistake of storing your timber in a new building. New buildings tend to have a lot of moisture building up from appliances, building materials, and technical equipment including concrete and plaster. New buildings subject stored timber to moisture which eventually ruins it.

Get the Positioning Right

Timber must be stored vertically, and on a flat surface to help it absorb air. The surface should be stable and evenly structured to prevent the timber from sinking in. Your timber is likely to warp if stored in an area that is not flat or solid. Instead of storing it on the floor, place it on pallets. Not only will your timber be protected from warping, but also against any moisture that could build up from the floor. However, ensure that the length of the pallet is not shorter than your timber otherwise warping could still occur.

Storing your timber in a clean and dry environment is vital. However, the storage facility must have a protective material. The material ensures that your supplies are protected from the outside elements and allows the timber to hold its natural moisture content. The cover must be waterproof even when storing the timber indoors given that water droplets can still build up in the indoor spaces.

LO 1.3 – Describe common defects in wood

- Content/Topic 1 Common wood defects

Introduction to wood defects

Defects in wood: These are flaws (fault or imperfection in timber) that result in weakness in wood or other wood products

Timber is far from being a stable and consistent material. One of the biggest challenges of working with timber is learning to work within the constraints of a timber's.

Various abnormal conditions and features of wood which permanently reduce the economic value of wood are termed as defects. The term is generally applied to the discontinuity of tissues and abnormal fibre development in wood, and unsoundness (inadequacy) to some form or stage of decay in wood. These defects and or unsoundness in wood may either just reduce its utility or render it entirely valueless.

How to select wood for project?

There is usually a best wood for any project you make. Study the characteristics of wood and you will see that all are not alike.

Here are something to think about as you select the wood for a project:

1. Consider the function of the project: Does its use affect the choice of wood? Where will it be used, in door or out door?
2. Consider the workability of the wood: Will the project be made by machine or by hand?

3. Consider the cost: Does the project deserve a scarce, high priced wood or will a more common one be appropriate?
4. Consider the beauty: Is the beauty of grain pattern and color important in the project? Is the design of project such that it will show off the beauty of the wood?
5. Consider the finish: Will a painted finish be used? Should the finish be water proof? Is a clear, natural finish preferred?
6. Consider the defects: Watch for shakes, warps, knots, etc

Your final choice will probably be a compromise, but whatever it is, have a good reason for it. Remember that the best piece of wood is not always in the middle of a board.

Defects in wood can be broadly classified into three main categories which are as follows:

(A) NATURAL DEFECTS/STRUCTURAL DEFECTS
(B) ARTIFICIAL DEFECTS/SEASONAL DEFECTS

(C) FUNGI AND INSECTS DEFECTS

(A) NATURAL DEFECTS:

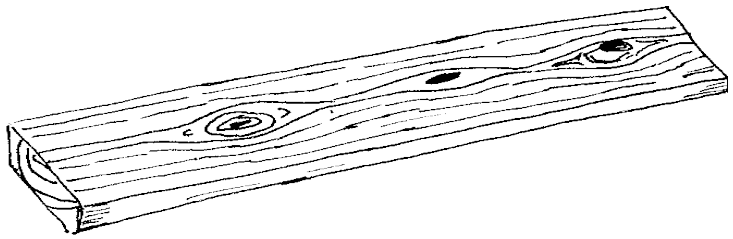
Defects that occurs during growth of which knots are the most common.

1. Knots: Knots are common types of natural defects. As the tree increases in diameter it covers the bases of the lateral branches. The portions of the branches enclosed within the wood are called knots. If the branches are alive at the time of inclusion, their tissues are continuous with main stem of the trees are called live knots. But when a branch dies and a part of it is gradually covered by the live tissues of the wood is called dead knots.

Knots vary in its size from Pin head several centimeters in diameters.

Classification of Knots:
(i) Pin knots: less than 6.5 mm in diameter.
(ii) Small knots: 6.5mm to 20mm in diameter
(iii) Medium knots: 20mm to 40mm in diameter
(iv) Large knots: above 40mm in diameter

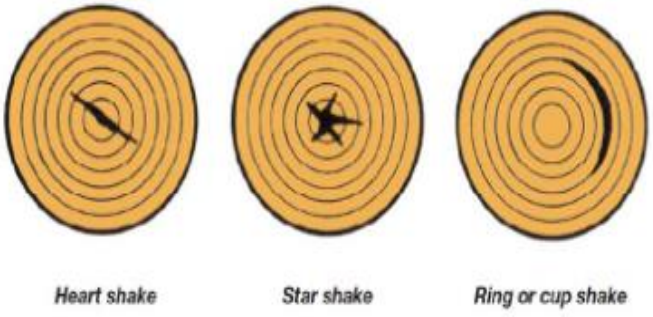
Knots spoil the appearance and reduce the strength properties of wood. It also raises the seasoning defects and makes difficulties during wood working.

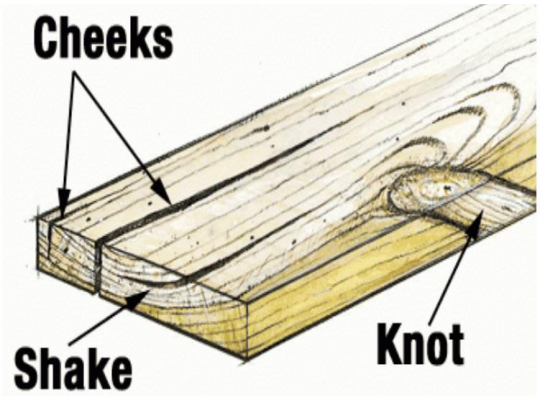


Larger the knots greater the strength reduction of the timber.

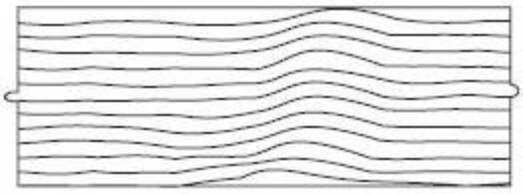
2. **Heart shake:** These occur in the heartwood of a tree when it is left too long after it has matured before being felled for use. It is due to lack of food. The shakes are cracks in the timber which appear due to excessive heat, frost or twisting due to wind during the growth of a tree. Depending upon the shape and the positions shakes can be classified as

- star shake,
- cup shake,
- ring shakes and
- heart shakes





Upset: These indicate wood fibres which are injured by crushing or compression. The upsets are mainly due to improper felling of tree and exposure of tree in its young age to **fast blowing wind**. This type of defect is due to **excessive compression** in the tree when it was young. Upset is an injury by crushing. This is also known as rupture.



Twisted fibers: These are known as wandering hearts, and is caused by twisting of young trees by **fast blowing wind**. The timbers with twisted fibers is unsuitable for sawing.

(B) ARTIFICIAL DEFECTS/SEASONAL DEFECTS

These are defects caused during treatment of felled timber (Seasoning defects and Conversion defects); the seasoning defects include:

- Warping,
- Split,
- Shake,
- Case hardening and the defects due to conversion includes:
- Box heart,
- Machine burnt (blueing),
- Machine notches (scratches),
- Imperfect grain

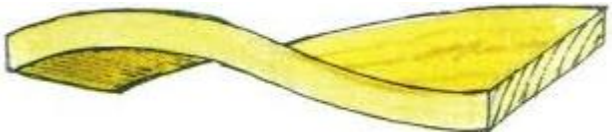
WARPING

Wood warping is a deviation from flatness in timber as a result of stresses and uneven shrinkage. Warping can also occur in wood considered "dry" (wood can take up and release moisture indefinitely), when it takes up moisture unevenly.

The types of wood warping include:

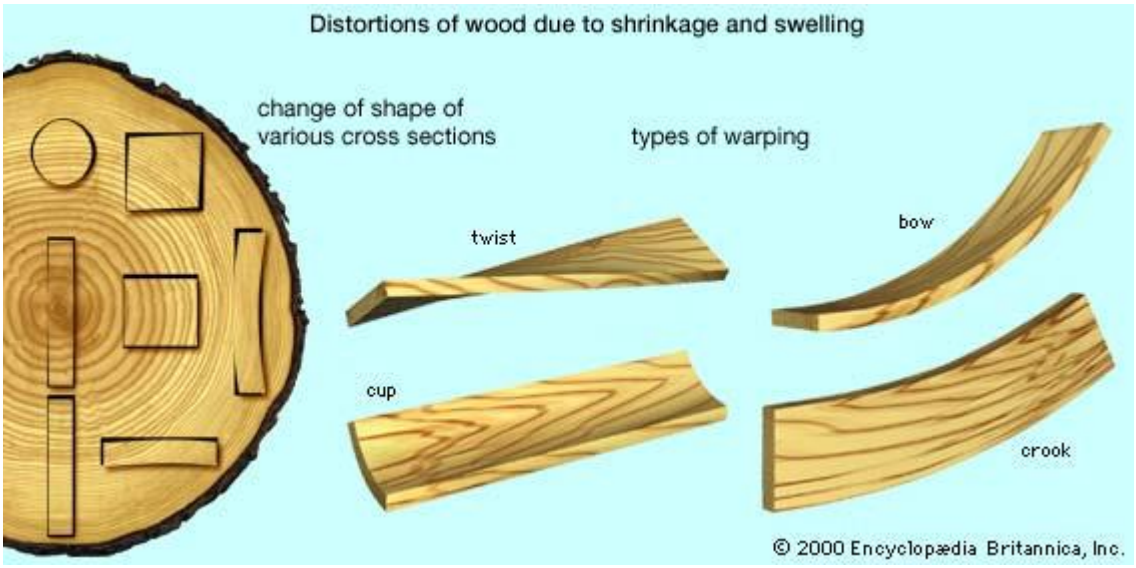
- **Bow**: a warp along the length of the face of the wood
- **Crook/Spring**: (also called wain) a warp along the length of the edge of the wood
- **Cup**: a warp across the width of the face, in which the edges are higher or lower than the center of the wood.
- **Twist** or **wind**: a distortion in which the two ends do not lie on the same plane.

Twist: Twist in timber rotates the ends of the timber in opposite directions. The main reason behind this defect is twisting of the trees by the strong wind.

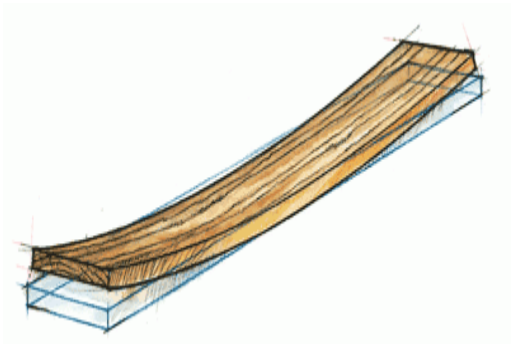


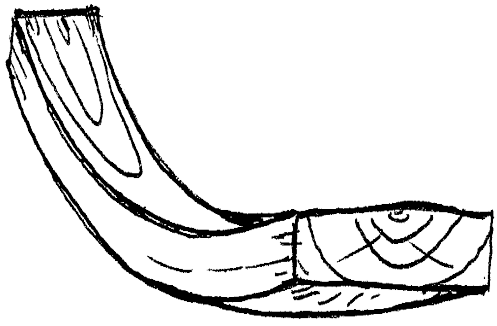
Cup: Warping along the face of a board across the width of the board. This defect is most common of plain-sawn lumber.

This cupping will occur in the outer boards of a stack when moisture is permitted to evaporate faster on one face than the other.



Bow: A board that rocks from end to end when laid on one face.



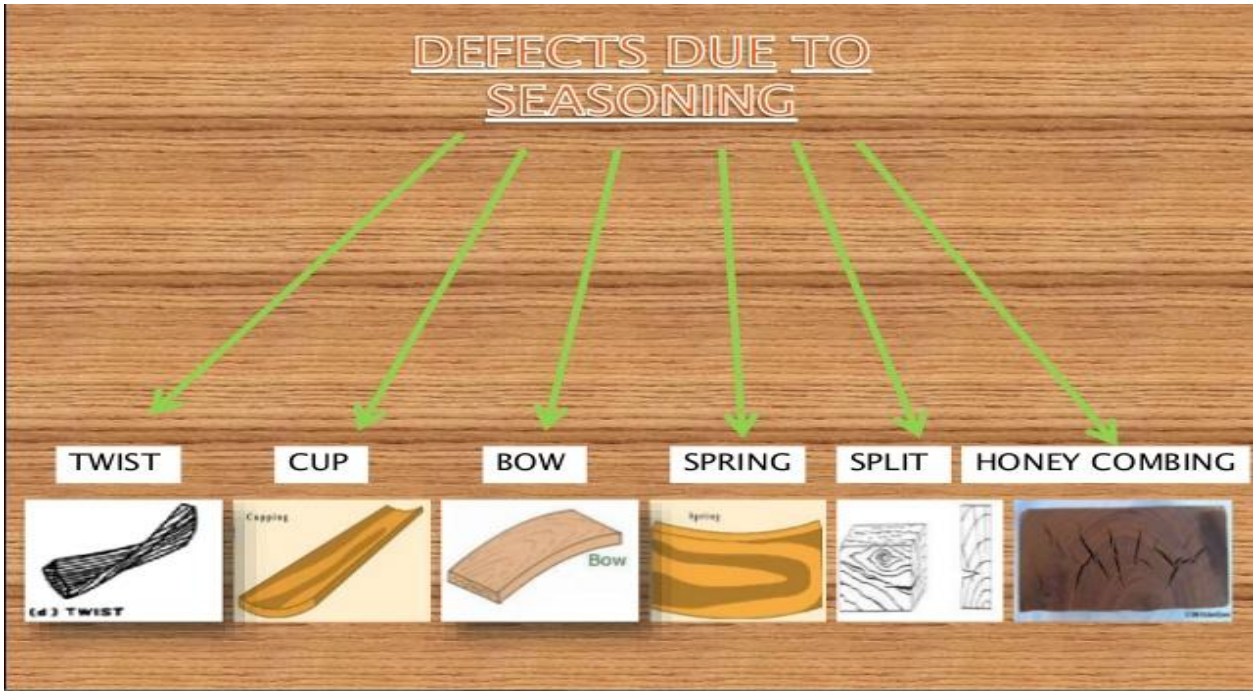


It is a seasoning and or storage defect caused by the failure to support the board with stickers at sufficient intervals. The boards own weight and probably those above it bears down and the resultant bow is inevitable.

This defect can and should be avoided by careful use of stickers supporting the board at the correct width.

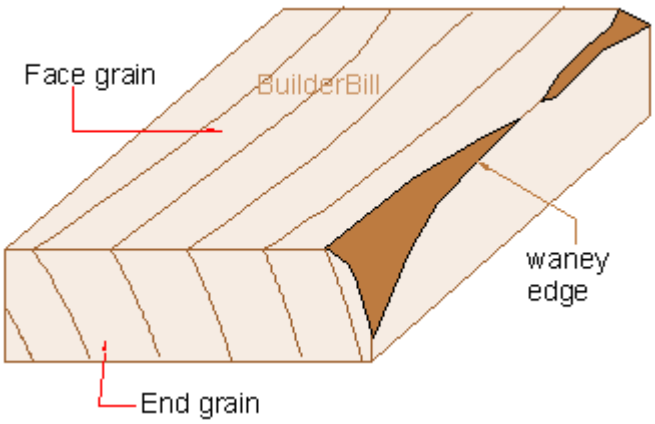
Crook – Where the board remains flat, but the ends move away from the center. Another type of warp.

Case hardening – When lumber or timber is dried too quickly, wood shrinks much at the surface, compressing its damp interior. Case-hardened wood may warp considerably and dangerously when the stress is released by sawing.



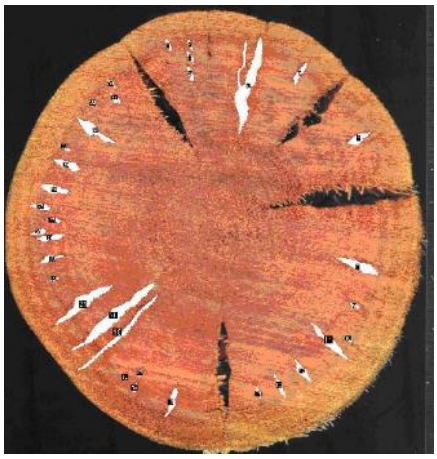
Wane – The presence of bark or the absence of wood on the corners or along the length of a piece of lumber. It is caused by too economic conversion of log.

Wane is defined as a defect in a plank or board characterized by bark or insufficient wood at a corner or along an edge, due to the curvature of the log.



HONEYCOMB

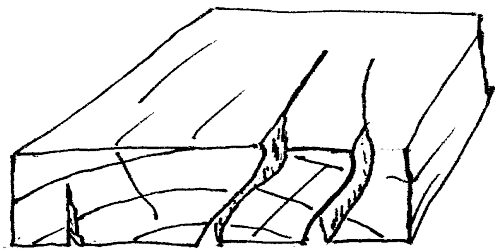
(Internal Checks) The development of checks in the interior of a piece of wood due to drying stresses, usually along the wood rays, often not visible at the surface. This defect occurs when thick timber is dried too quickly in a seasoning-kiln.



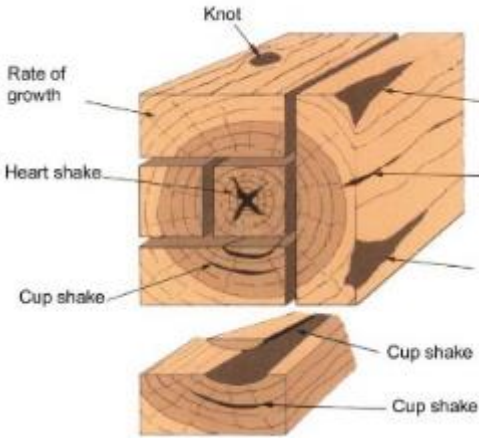
Case hardening: Moisture is lost from the outside surface of a board first, and as the surface layers dry below 30% shrinkage occurs. The surface shrinkage is restrained by the inner part of the board which has not yet started to shrink.

Split – A split is a rupture or separation in the wood grain which reduces a board's appearance, strength, or utility. One of the more typical ruptures of this type is called ring shake. In a ring shake (also known as cup shake or wind shake), the rupture runs parallel to the growth rings. It's not easily detected in green logs and lumber, but only becomes apparent after drying. It's caused by any one of numerous factors, including bacteria, tree wounds, tree age, and environmental conditions.

It is usual in end grain and is remedied by cutting away the defected area. All boards should have an allowance so that some end grain may be cut away because of possible shakes or splits.



Box hearts: These are defects that occur within a growing tree, and can influence the strength and appearance of the surface of the timber.



Machine burnt: Discoloration of the wood due to overheating caused by friction, and either scorching the wood or the resins within it. Machine burn is caused by stopping or not feeding the wood across the blades at the correct rate of speed.

Machine notches: Due to bad holding and pulling**.**
Imperfect grain: Not matching with grain alignment.

Shrinkage and Swelling.
The newly cut wood loses moisture when subject to drying naturally or artificially. On drying, the wood undergoes a shrinkage.

Similarly, dry wood on getting rain melted or wetted may undergo considerable swelling.

It is known that in the drying process, moisture from the wood is lost first from the cell cavity and then from the cell walls.

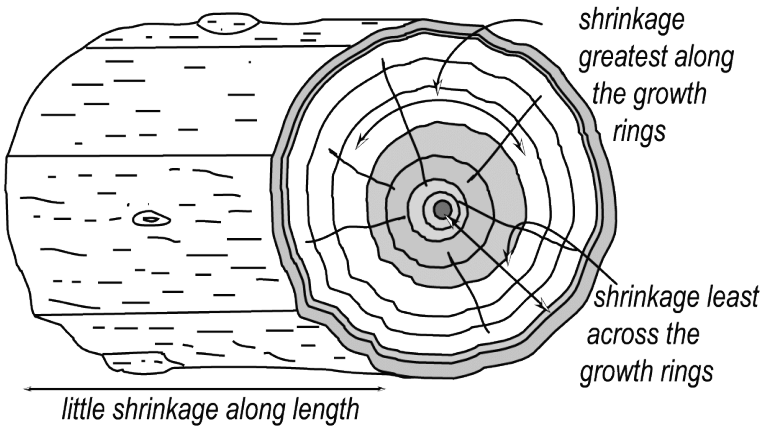
It is only when the water is lost from the cell walls then the wood starts shrinking.
Conversely, when dry wood is wetted the water is first received by the cell walls.
Only when the walls become saturated, water goes to the cell cavities.
Hence, on wetting, the swelling starts quickly.
Thus, shrinkage and swelling are related to the behavior of the cell wall of the wood tissue towards the water.
It is now fairly established that:

1. Thick walled cells shrink more than the thin-walled cells.
It is for this reason that the hardwoods shrink more than the softwoods.

2. Shrinkage in the longitudinal direction is least (0.1 to 0.5 percent) whereas it is highest (7 to 15 percent) in a direction tangential to cell walls.

It is because in the latter case “full width” of the cell walls is involved. In the radial direction, it is of an intermediate order.

3. Deformation is caused by the board cut from timber due to shrinkage and swelling.
The extent of deformation will depend on the direction in which it has been cut with respect to the grain of the tree.



(C)FUNGI AND INSECTS DEFECTS

FUNGI: Are plants which depends on organic matter for their food.

(a) Stain: Fungi causing stain in wood, when it feeds only on food materials stored in the sapwood. In this case, fungi do not attack the heart wood which normally does not contain food material within the cell. Stain defect does not affect strength properties of wood.

(b) Decay: This is observed due to wood destroying or wood rotting fungus of wood. These fungi nourish cell wall material and break down the cell structure and enzymatic activities. Decay fungi attack both sapwood and heartwood. This defect reduces the strength properties of wood.

They are 2 types of fungi, these are:

A. DRY ROT
B. WET ROT

The main cause of rot is moisture in timbers. Wood destroying fungus feed off this moisture and as a result visible signs of dry rot or wet rot damage appear on the affected timber. Wet and Dry rot spores will only develop and take hold of timbers if the environmental conditions are correct.

In order to prevent rot it is essential that you fix ventilation issues and damp problems, such as rising damp, penetrating damp and condensation as they are the main causes of excessive moisture within a property.

DRY ROT

Dry rot, also known as brown rot, is wood decay caused by fungi.

How Does Dry Rot Spread?

The dry rot fungus produces spores, which are spread through the air. They will germinate if they land on wood that's been exposed to a high level of moisture from one of these 3 sources:

1. The wood was not properly kiln-dried before being used in construction, to lower its moisture content below 20 percent.

2. The location of the wood is an area of the home with excessive humidity.

3. There has been direct contact with large quantities of water, for example, flooding from a burst pipe.

If not stopped, dry rot will weaken the wood to a point that it could literally disintegrate.

Signs of Dry Rot

Dry rot can be problematic to any property so it is essential that you identify signs of dry rot before further damage is done. If you notice the following then it could indicate a dry rot problem:

- Distinct mushroom smell
- White fungal growth with yellow and blue dashes
- Deep cracks appear within the wood
- Both soft and hardwood timbers can be damaged

WET ROT

Wet rot is **timber** that is decaying naturally in the presence of high moisture levels. **Wet rot** is, therefore, a general term used to describe a variety of fungal species responsible for **wood rot.**

The common signs of wet rot include:

- Darkened timber – darker than surrounding timber
- Soft and spongy timber
- Cracked appearance that may crumble to touch when dry
- Shrinkage
- A damp, musty smell

What are the main difference?

Wet rot and Dry rot are two different types of fungi. One of the main differences between wet rot and dry rot is that wet rot needs a higher moisture content to grow. Wet rot fungus likes to grow on timber with a high moisture content of around 50% and above while for dry rot to grow it will germinate at a lower timber moisture content of around 20% to 30%.

INSECT OR BEETTLE

Insects: Insects borers and termites together constitute one of the most destructive biological agencies causing defects in timber. Some insects infest standing trees others infest felled logs before conversion or converted timber. The damage is visible in the form of tunnels and wood dust packed galleries in timber.

Insect defects – There are a number of insects that eat wood. Many other insects use wood as a nesting place for their larvae which results in holes and tunnels in the wood. The damage they cause ranges from minor to catastrophic. Some of the more common insects include:

- ✓ Pin-hole borers
- ✓ Termites
- ✓ Common Furniture beetle
- ✓ Deathwatch beetle
- ✓ Powder Post beetle
- ✓ House Longhorn beetle

LO 1.4 – Preserve timber

Introduction to timber preservation.

Wood preservation (timber treatment) refers as all measures that are taken to ensure a long life of wood.

Wood preservation provides protection to wood against fungi and insects that may damage and eventually destroy it. The primary **purpose** of preservation of wood is to increase its service life.

- Content/Topic 1 Timber preservatives

There are three main classes of timber preservatives:

- **Oil type preservatives**

Coal tar oil is the best known and widely used preservative material of this class. It is obtained during the destructive distillation of bituminous coal. It is available in many grades and types. It has high degree of penetration. It has highly toxic effect to wood destroying fungi. These include **pentachlorophenol** and **creosote**. They are toxic, have an unpleasant odour and are generally not used in consumer products.

- **Solvent preservatives**

Organic Solvent Preservatives are preservatives that contain insecticides for internal use, and combinations of fungicides and insecticides for external use, and sometimes water repellents. All of these preservative components are incorporated in a solvent carrier such as white spirit.

Organic Solvent Preservatives are used to protect timber against insects, including termites, and decay, though they are not intended for use in ground-contact situations. In addition, Organic Solvent Preservatives can provide a degree of weather protection when water repellents have been incorporated. Organic Solvent Preservatives are preservatives that leave the treated timber dry after treatment, and do not cause it to swell and distort in any way.

Organic Solvent Preservatives have traditionally been colourless, and although it is now possible to obtain green and brown-coloured Organic Solvent Preservatives, such colour that is imparted to the timber by these coloured variants is short-term. Also, it should be noted that some of the dyes used in coloured Organic Solvent Preservatives might migrate through paint films that are later applied to the surface of the Organic Solvent Preservatives -treated timber.

The colour or general visual appearance of a piece of treated timber is not a reliable guide for identifying the actual preservative used. Users should check the marking (or branding) on the treated timber, or ask the supplier if in doubt. For example, some Organic Solvent Preservatives is tinted green, but this should not be confused with the green copper chrome arsenic (CCA) used in ground contact applications, for which Organic Solvent Preservatives are unsuitable.

Use a medium of organic solvents to transmit the toxic chemicals into the wood. After application, the solvents evaporate, leaving the wood toxic to insects and/or fungi.

- **Water soluble preservatives/water borne**

It is clean and odorless. Water is the most common solvent carrier in preservative formulations due to its availability and low cost.

I**. Chromated copper arsenate (CCA)**:

- It consists of copper sulphate,arsenic pentoxide and sodium dichromate in the proportion 3:1:4.

II**. Chromated zinc chloride**: - It consists of zinc chloride and sodium dichromate in the ratio 1:1.

III**. Copper chrome boric composition**: - It consists of boric acid, copper sulphate and sodium dichromate in the ratio 1.5:3:4.

IV. Zinc metal arsenate: - It consists of arsenious trioxide and zinc oxide in the ratio 3:2.

V. Acid cupric chromate composition: - It consists of 1.68 parts of chromic acid, 50 parts of copper sulphate and 47.5 parts sodium dichromate.

VI. Zinc chrome boric composition: - It consists of 1 part of boric acid, 3 parts of zinc chloride and 4 parts of sodium dichromate in 100 parts of water.

Requirements of a good preservative:

♣Cheap and easily available.
♣Should allow coats of paints etc. without discolouring.
♣Highly penetrative.
♣Should be of permanent nature.
♣Should be extremely poisonous, even in small doses, fungi and other insects.
♣Shouldn't reduce the strength of the timber and should be non-corrosive to metals in contact.
♣Should not catch fire easily.
♣Shouldn't give bad smell
♣Should not be injurious to workmen.

LO 2.1 – Identify, describe basic hand tools and safety.

- Content/Topic 1 Identification and description of basic hand tools with their safety.

Carpentry is one of the most ancient of craft, yet it is surprising how many of the tools still in use today are updated versions of those used by the early carpentry art.

Modern materials and production methods have made it possible to produce tools of good and testing quality.

These tools can be classified into 5 groups:

A. Holding tools
B. Setting out tools
C. Cutting and shaving tools
D. Boring tools or percussion tools
E. Fixing or impelling tools.

HOLDING TOOLS

Holding tools are general-purpose mechanical aids used in the preparation and assembly of timber or metal component.

These are:

✓ Bench vice

✓ Clamps (Sash clamps, T-bar clamps, G-clamps, F-Clamps)



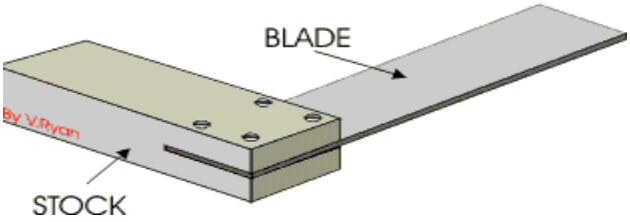

✓ Workbench

SETTING OUT TOOLS

Tape measure: - Is used for measuring straight lines and setting out work. Usually graduated in mm and cm length and inches.

Pencil: - Is used for marking and setting out lines on the prepared timber.

Try square: - These are made either all metal or with a wooden stock and metal blade. They are supplied with blades ranging from 100 mm to 450 mm in length and are used for either squaring lines across the face or edge of timber, for testing the squareness of the edge from the face, and for testing the flatness of the timber surface.

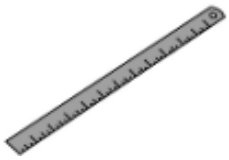


Combination Try Square: - It is a tool that combines four marking-out tools in one. It has a slotted blade passing through a stock which gives a right angle on one side and a mitre angle on the other. Attached to the stock is a small spirit level for testing level and uprightness. Because of the adjustable stock it is possible to use it as a marking gauge.

Sliding Bevel: - The sliding bevel can be set to any angle other than a right angle. These can be obtained with either a wood or metal stock, with a sliding blade from 150 mm to 300 mm length which is fixed, in the case of a wooden stock by a screw or lever nut, and in the case of a metal stock by a blade clamping screw which runs down the centre of the stock.

Steel rule

Good for fine measurements, also able to be used as a straight edge



Folding rule

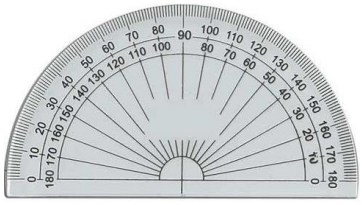
Not so popular these days, but still sometimes used by carpenters.

Vernier caliper

Used for measuring thicknesses and diameters very precisely.

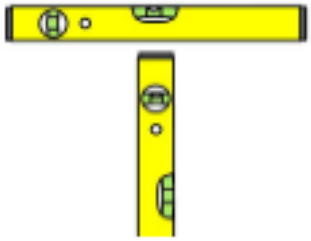
Protractor

Like a bevel, but has the degrees marked in an arc.



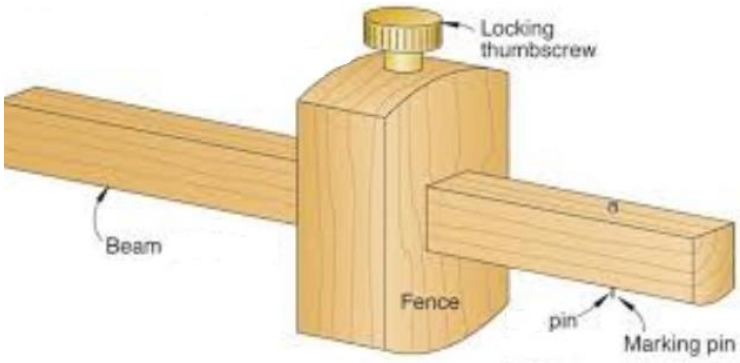
Spirit level

Uses a bubble to show whether a line or surface is level (perfectly horizontal) or plumb (perfectly vertical).



Marking gauge, also known as a **scratch gauge**, is used in woodworking and metal working to mark out lines for cutting or other operations. The purpose of the gauge is to scribe a line parallel to a reference edge or surface. It is used in joinery and sheet metal operations.

The gauge consists of a beam, a headstock, and a scribing or marking implement, typically a pin, knife, pen or wheel. The headstock slides along the beam, and is locked in place by various means: a locking screw, cam lever, or a wedge. The marking implement is fixed to one end of the beam.



Mortise gauge is a woodworking tool used by a carpenter or joiner to scribe mortise and tenon joints on wood prior to cutting. Mortise gauges are commonly made of hardwood with brass fittings.

CUTTING AND SHAVING TOOLS

They are divided into 2 groups:

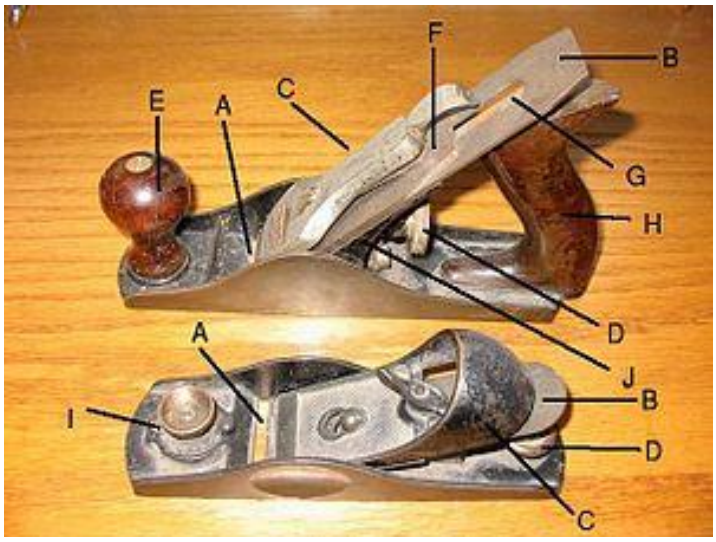
a) Slicing and smoothing tools

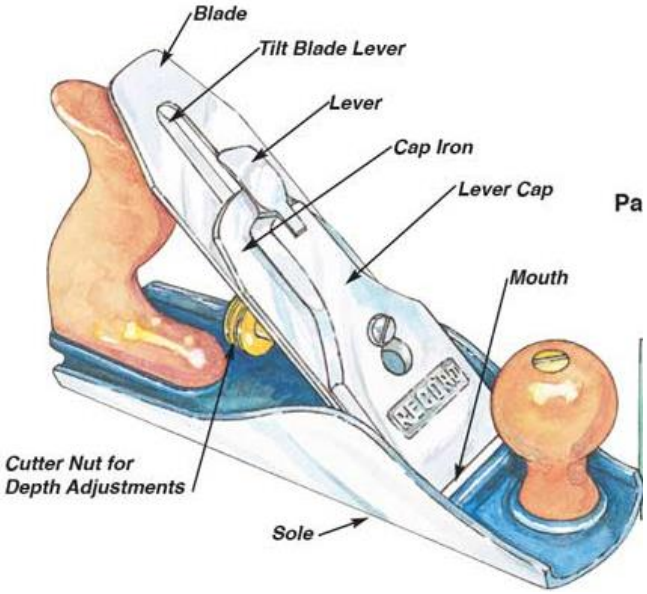
1. Wood or steel jointing planes
2. Wood or steel jack plane
3. Wood or steel rebate plane
4. Plough plane for grooving
5. Compass plane for planning hollow or rounds.
6. Router plane for making mouldings
7. Spoke shave for planning rounds
8. Bullnose for planning dadoes or housing.
9. Chisels

10. Gauges for turning in wood lathe, are thick and heavier, the ordinary are used for chopping in grooving works curving.
11. Files

The standard components of a hand plane include:

- A: The **mouth** is an opening in the sole of the plane through which the blade extends, and through which wood shavings rise.
- B: The **iron** is a steel blade which cuts the wood.
- C: The **lever cap** secures the cap iron and iron firmly to the frog.
- D: The **depth adjustment knob** controls the cutting depth of the iron.
- E: The **knob** allows a second hand to guide the plane.
- F: The **cap iron** or **chipbreaker** reinforces the iron and curls and breaks apart wood shavings as they pass through the mouth.
- G: The **lateral adjustment lever** skews the iron so that the depth of cut is uniform across the mouth.
- H: The **tote** is the principal handle for gripping the plane.
- I: Is **cam lever** which pivots a sliding section of the forward end of the sole to adjust the gap in the plane's mouth. It is anchored to the threaded post of the knob and secured by tightening the knob.
- J: The **frog** is an adjustable iron wedge that holds the plane iron at the proper angle and allows it to be varied in depth relative to the sole. The frog is screwed down to the inside of the sole through two parallel slots and on many planes is only adjustable with a screwdriver when the plane iron is removed.
- The **sole** is the bottom face of the plane.





b) Parting and shaving tools.

SAWS:

Generally, saws can classified into 3 families:

1. Rip saw
2. Cross cut saw
3. Panel saw

Rip saw

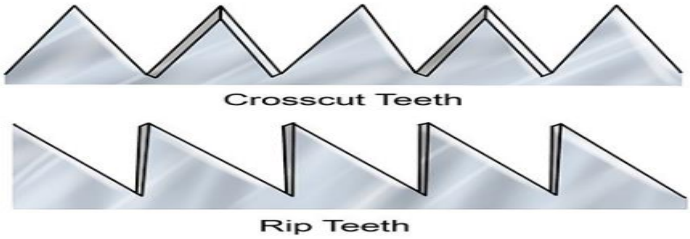
Ripping saw cut following the direction of fibers. Rip saws are the largest and coarsest of the saws.

Their length: 650 – 710 mm

Their teeth: 3-5 teeth/inches

Cross cut saw

Cross cut saws cut wood across. Their length is between 510-660 mm long and 7-8 teeth at 25 mm or inch or 6-11 teeth at 25 mm long or 1 inch.

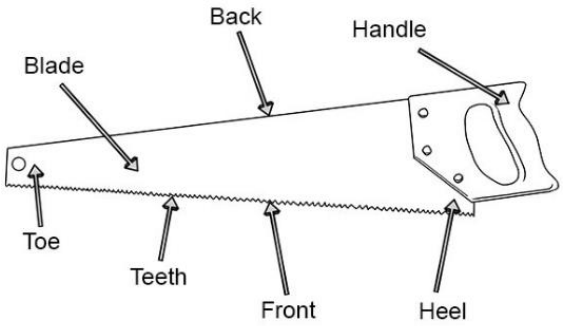


Panel saw

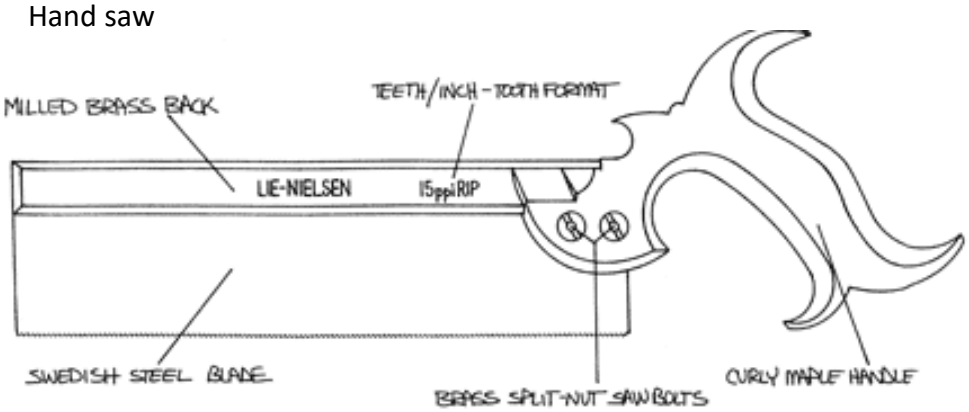
Panel saws are the finest of the handsaws. Their length is usually between 550-610 mm. They have 10-12 teeth/inch

But broadly speaking, saws can be categorized into four groups:

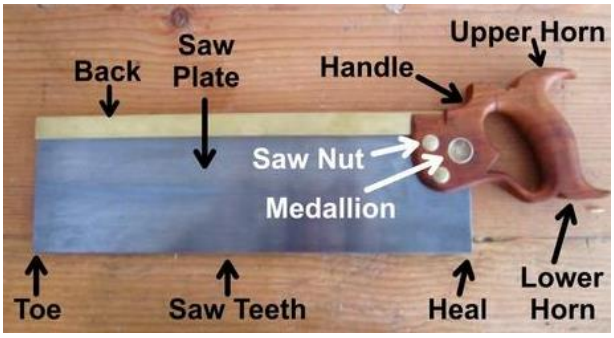
- **Hand saws**
- **Backed saws**
- **Framed saws**
- **Narrow-bladed saws**.



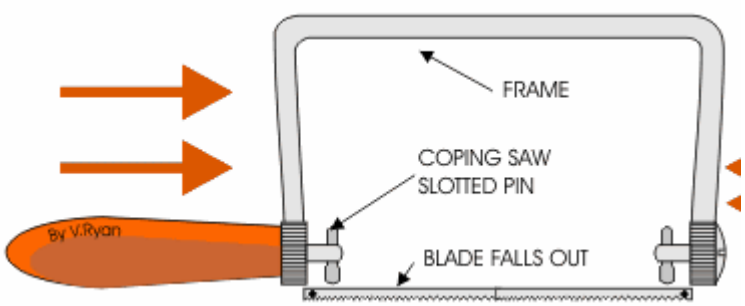
Hand saw

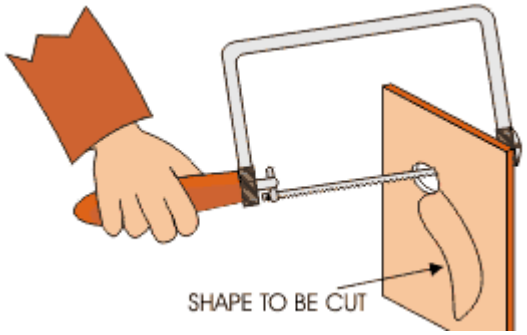


Back saw/Dovetail saw

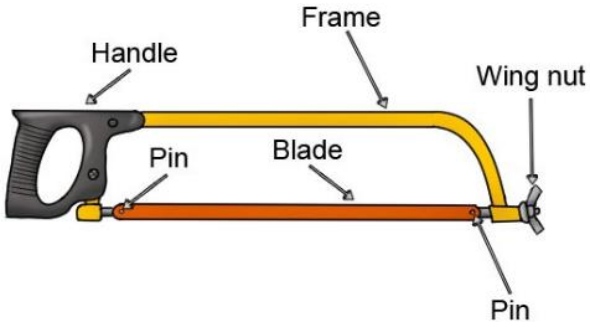


Back saw/ tenon saw





Framed saw/Copping saw



Framed saw/ Hack saw

Narrow bladed saw/pad saw

Narrow bladed saw/ Compass saw

1. Hand saws for ripping and also cross cutting (in both group)
2. Tenon saws for cutting tenon and tenon shoulders
3. Key hole saw or compass saw (for cutting cylinder holes).Padsaw is similar to key hole saw the difference is handle adjustable.
4. Back saw for fine joinery works.
5. Bow saw with a wooden frame for ripping and cross cutting difference is blade size

BORING TOOLS OR PERCUSSION TOOLS

1. Single brace
2. Ratchet brace
3. Twist brace
4. Auger bit
5. Dowel bit
6. Plug bit
7. Gimlet bit
8. Turn screw bit to fit braces
9. Expansion bits
10. Shell boring bit
11. Counter sink bit
12. Dowel sharpener bit

FIXING TOOLS or IMPELLING TOOLS

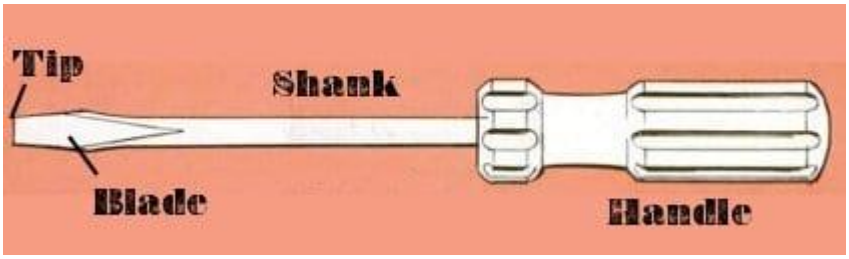
Tools which gives force to other tools.

1. Wood mallets
2. Warrington hammers
3. Panel pin hammers
4. Pincers
5. Pliers
6. Screw drivers:
   - -Ordinary/ flat
   - -Star/Pozidriv
   - - Phillips

NAMES AND PARTS OF SOME TOOLS

The screwdriver consists of four parts:

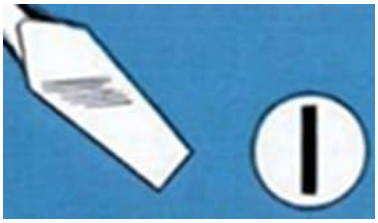
1) The handle,
2) The shank,
3) The blade, and
4) The tip.



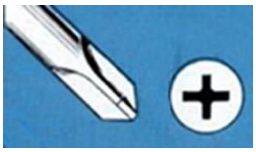
Types of Screwdrivers

Screwdrivers are distinguished from each other based on their tip and what type of screw they drive. The two most common screwdriver tips are

1) The slot head screwdriver, and **Slot head screwdriver (Flathead/regular screwdriver).** A slot head screwdriver consists of a single, flat blade that fits in the single slot of traditional screws. It's the oldest and most common screwdriver in the world.

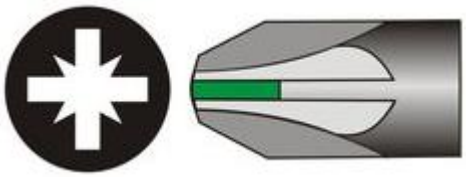


2) The Phillips-head screwdriver.



Pozidriv-head Screwdriver. A Phillips-head screwdriver has a four star point at the end that fits into the corresponding screw's shallow, cross-shaped depression. This design allows a user to apply more torque than is possible with a flathead screwdriver.
The name Pozidriv is the abbreviation or acronym for "positive drive".

Phillips screw
The Phillips Screw Company and the American Screw Company patented a cross-head screw with parallel flanks which prevents the ejection force during tightening or loosening.



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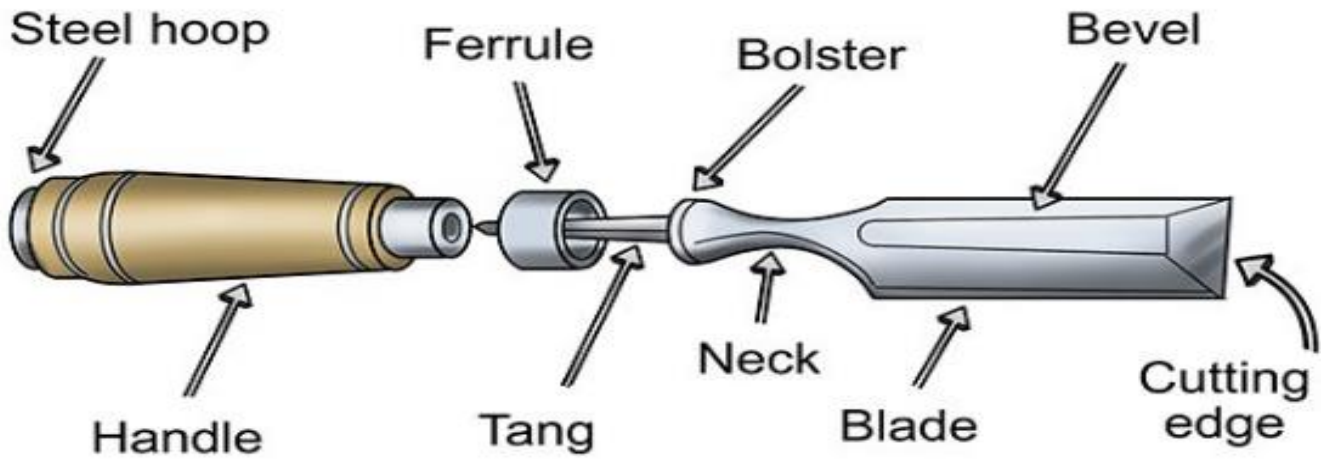

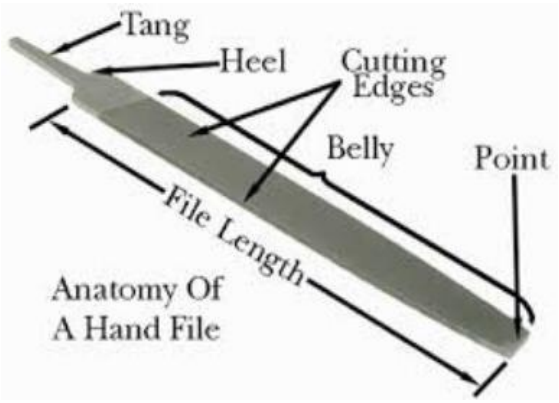

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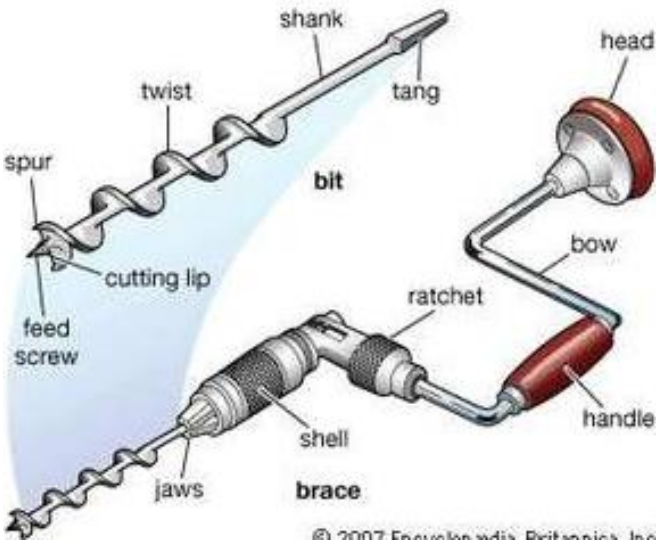
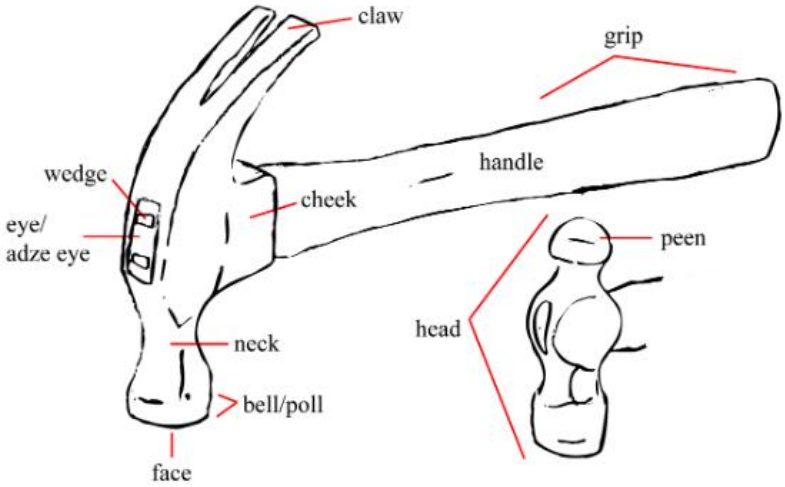


Ratchet brace



Claw hammer

Safety precautions of using carpentry hand tools.

Safety precaution in the workshop goes hand in hand with maintenance of tools. It is because a carpenter is expected to know much about cutting tools so as to protect himself from injuries.

Here below are some of precautions that a carpenter must observe while in the workshop:

- Move in orderly way while in the workshop.
- Never run in the workshop
- Replace all necessary tools
- Carry all sharp tools in sheath (cover).
- Tag worn put (put aside), damaged or defective tools "Out of Service" and do not use them.
- When handing a tool to another person, direct sharp points and cutting edges away from yourself and the other person.
- Do not carry sharp or pointed hand tools such as probes or knives in your pocket unless the tool or your pocket is sheathed.
- Do not throw tools from one location to another or from one employee to another.

- Transport hand tools only in tool boxes or tool belts.
- Use a tool of the right size
- Inspect hand saw before every use
- Wear all PPE (Personal Protective Clothing)(overall, strong boat, helmet, gloves, dust mask, Goggles,….)
- Inspect every tool before every use
- Check material for knots or nails
- Never test sharpness with hands
- Start slowly while working
- Ensure that the material is kept firmly in place
- Store in a safe place

LO 2.2 – Use, maintain and store safety hand tools

- Content/Topic 1 Storing and maintenance of hand tools

Maintenance of hand tools:

- **Resharpening**

A set of grindstones or bench stones is the core of most sharpening systems. These are available in different sizes, shapes, and grits. The materials are either natural stone or synthetic abrasives in a hard binder. Many stones are used with light oil or water. The liquid cleans the surfaces, moving away the *swarf* (metal particles). On sharpening machines, liquids also serve as a coolant, keeping the tool steel from overheating and losing some of its hardness.

Honing (sharpening using an oilstone)

All of this can be done with several effective types of sharpening tools:

- Waterstones, aluminum oxide or ceramic
- Diamond stones
- Sandpaper of various grits adhered to thick, flat glass (float glass)
- Oil stones

Sharpening and Setting Sawblades (saw reconditioning)

Why sharpen?

Today's mass produced, plastic handled and Teflon-coated disposable saws are a poor comparison to the quality saw of old; they never inspire any loyalty, for they are designed to be simply thrown away as soon as they get blunt.

Which saws can be sharpened?

Basically, any saw that has not got special hardened teeth can be sharpened. Saws with hardened teeth - which means the majority of saws sold today - cannot be sharpened in the normal sense of the word. Hardened teeth have exactly the same hardness as the saw file, which thus can have no effect on them, so you only can use diamond files! Many manufacturers only harden the tips of the teeth, which has the advantage that they later break off less easily, but the disadvantage that once the topmost layer has been worn away the soft metal below is exposed.

What tools are required?

You need only a few tools:

- A flat file,
- A saw vise or alternatively two boards with clamps,
- A saw file and
- A saw set.

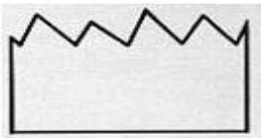
What are the stages of the work?

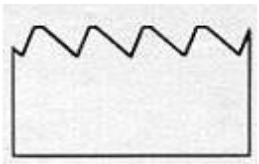
Getting saws back into shape for sawing involves four successive processes

- Trimming,
- Shaping,
- Setting and
- Sharpening the teeth, in that order. Depending on the state the teeth are in, you can start at stage 4 or have to begin at the beginning

1. Trimming/ Topping

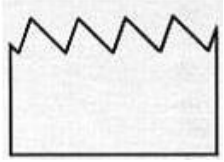
Repeated sharpening will alter the shape and height of the teeth. The row of the teeth, which originally stood as a neat rank becomes ragged, the teeth that have been shortened are not up to the mark and are no longer doing any of the sawing - the cutting performance tails off. Trimming will make the saw's teeth usable again. To do so, one fixes the saw in the saw vise and files back and forth over the row of the teeth with a flat file until a top surface has been produced on the point of every tooth. The odd extremely short tooth can be accepted.

 If this is what your saw blade looks like, it needs trimming!

 This is what your saw blade will look like when it has been trimmed.

2. Shaping the teeth

The saw blade is now treated to even filing with a 3-sided file, so that each tooth without exception receives 3 or 4 strokes of the file overall. The process is repeated until all the teeth are the same shape and the base of the teeth is in a neat line.



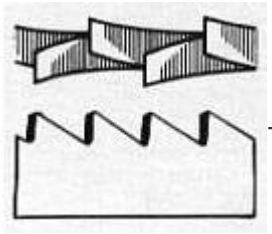
A crosscut saw blade after the teeth have been reshaped.

3. Setting

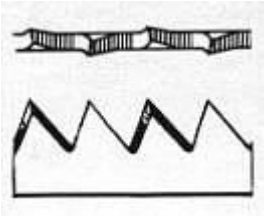
Setting a saw means bending alternate teeth outwards to either side, making the cut wider than the blade, so that the latter does not jam. The offset must be absolutely equal to both sides, or else the saw will go off course in the direction of the wider offset side. For this job you need a saw set. To avoid tooth breakage, never bend a tooth to the right that was previously bent to the left, and vice versa.

4. Sharpening

Sharpening should take place after the setting, to avoid the tool damaging the teeth. A three-square saw file is required for the task. First the sawblade must be clamped in the saw vise right up close to the base of the teeth, to avoid vibration. The file should just be able to pass above the jaws (between teeth). It is guided horizontally through the gap between the teeth, at right angles to the blade when sharpening a rip cut saw. When sharpening a cross cut saw, the file must be guided horizontally at a 60 ° angle.



Teeth of a rip saw after they have been correctly set and sharpened.



Teeth of a crosscut saw after they have been correctly set and sharpened.

- **Oiling and greasing**

Difference between Oil and Grease

1. Both oil and grease are generally used by people to lubricate machine parts, tools and equipment that are used every day.

2. Grease is made out of either animal fat or a combination of different minerals that are found in nature. Oil is extracted from animal fat or plant extracts.

3. Grease is semisolid in its appearance and not easily affected by extreme temperatures, which is why they are commonly used in tools, machines and equipment. Oil, in room temperature, is liquid and becomes solid when subjected to extremely low temperatures, and tends to evaporate when subjected to extremely high temperatures. Oil is used by people in cooking, personal grooming, lubrication and so much more.
Lubrication is a process which aims at reducing friction between two moving pieces. When two surfaces come in contact with one another, a fluid must be injected to separate them. The word « greasing » applies when grease is used to lubricate.

What are the main purposes of lubrication?

Lubrication allows to:

- Reduce friction (rubbing or deformation)
- Absorb/reduce shocks
- Protect from corrosion
- Isolate components from contamination
- Clean/get rid of contaminants.

Lubricants aim at reducing friction between moving pieces and at reducing passive resistance of the stationary parts. They are produced by refining (purifying) heavy fractions of crude oil (remaining crude oil parts after refining hydrocarbons such as gas, fuel oil or kerosene). There are different kinds of lubricants: liquid or fluid (oils), semi-solid (grease, silicon gels) or solid (Teflon, graphite).

Performances and characteristics may differ from one lubricant to another, but they all have in common the same main component called “base oil”.

Oils

Oils are a mixture of lubricating base oil and additives.

There are between 15% and 25% additives in finished oils for two reasons:

- Either to reinforce some properties of the base oil
- Or to give new properties to the base oil

Cutting oils

Some liquids are used to cool down and to lubricate the equipment during cutting operations. The cooling process increases the tool lifetime and makes it easier to obtain standard cuttings on finished pieces. Lubrication enables to reduce frictions, which avoids excessive heat releases and reduces the energy necessary for a particular cutting.

Greases stand out in particular for their excellent adhesion to the surfaces to be lubricated; also, they are insoluble in water, they resist to shearing and last longer.

In addition to its lubricating role (reduction of mechanical fatigue and energy losses due to friction), grease creates a waterproof barrier against external elements (dust, water, solvents, heat, etc.).

LUBRICATING TOOLS

These lubricating tools have metallic body, made of steel or brass.

Use grease When:

• You need lubrication to stay put and stick to surfaces for a long time

• You want to seal out contaminants such as water or dust

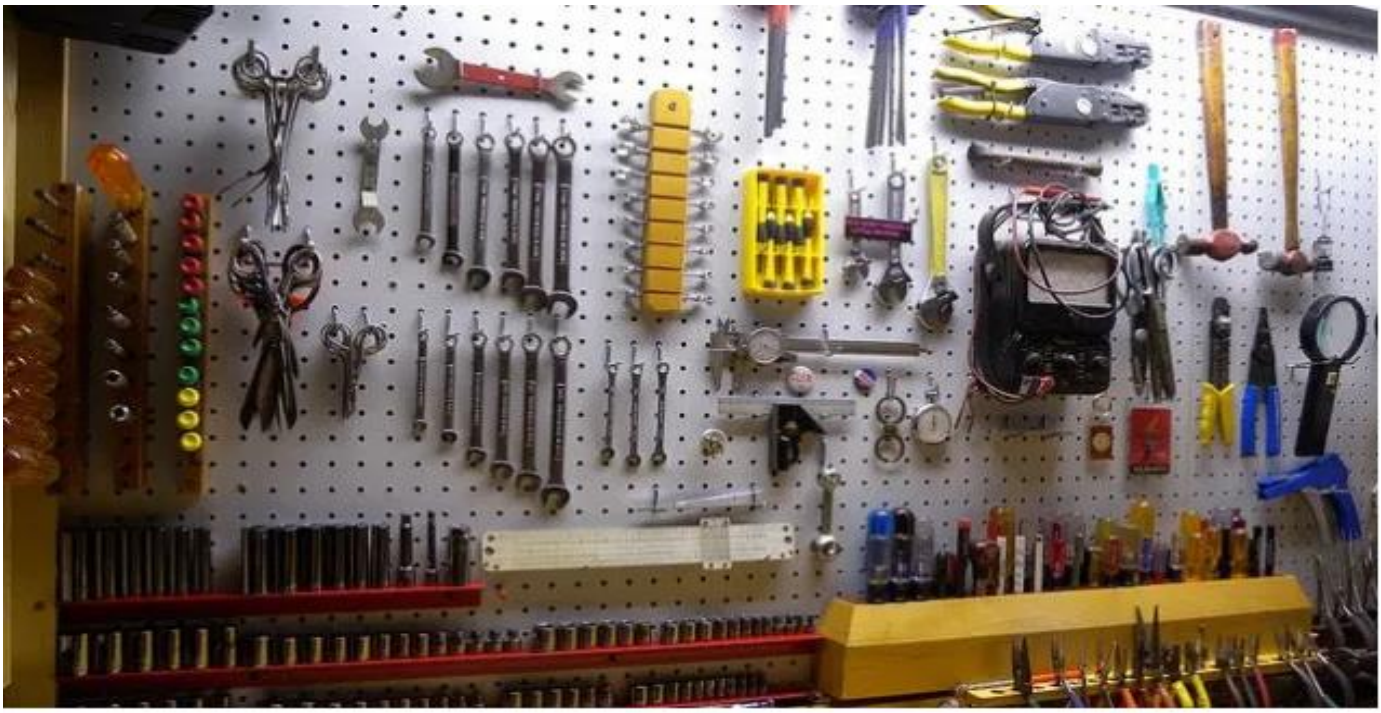
• You use a machine so infrequently that you may forget to oil it

Don’t Use grease When:

• You have fine or fast-moving mechanisms where thick grease would create too much resistance

• You don’t want a mess (uncleanliness). When parts move, they can fling grease all around, so it may not be the best option for keeping things clean

Store Your Tools Properly



You have to work with the space you have. Maybe you hang them on pegboards, maybe you store them in boxes, bags, or chests, or maybe you keep them in drawers or on shelves in your shop. Whatever works for you is best.

Pegboards make a great storage system for tools. They let you see all your tools at a glance and they can make use of wall space in a pretty efficient way. If you don't have enough wall space, though, you can still take advantage of pegboards by building a hinged system, a rolling pegboard, or even a portable pegboard storage system.

Rust is public enemy number one when it comes to tools. To avoid rust when storing your tools:

- Keep your tools in a dry place.

- Store power tools in their original cases.
- Inspect (and Repair) Your Tools Every Time You Use Them
- Sharpen your tools after every use.

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