UNIVERSITY OF AGRICULTURAL SCIENCES
DEPARTMENT OF AGRICULTURAL ENGINEERING

G.K.V.K, Bengaluru-560065

Extended Syllabus

WORKSHOP TECHNOLOGY & PRACTICES - FPM 111 (1+2)

I Year I Semester B.Tech (Agri. Engg.) (Academic Year 2018-19)

Course Teacher: Er.TEJAS K.S

THEORY

1. Carpentry

- Definition
- Introduction to Timber
  - Structure of wood
- Classification of wood & their characteristics
  - Soft wood
  - Hard wood
- Difference b/w hard & soft wood
- Seasoning of wood
  - Natural seasoning (Air)
  - Artificial seasoning
- Timber preservation
- Miscellaneous material used in carpentry shop
  - Nails
  - Screws
  - Adhesives
  - Paint & Varnishes
- Common carpentry tools
  - Marking & measuring tools
  - Planing tools
  - Cutting tools
  - Boring tools
  - Striking tools
  - Holding tools
- Carpentry process
  - Marking
  - Sawing
  - Planing
  - Boring
  - Grooving
  - Chiselling
- Carpentry joints
  - Halving joints
  - Butt or rubbed joint
  - Dowel joint
  - Dovetail joint
  - Corner joint

CARPENTRY

The activity or occupation of making or repairing things in wood.
The work made or done by a carpenter.
The art of shaping and assembling structural woodwork.

10.1 INTRODUCTION

Carpentry and *joinery* are common terms used with any class of work with wood. Strictly speaking, carpentry deals with all works of a carpentry such as roofs, floors, partitions, etc. of a building, while joinery deals with the making of doors, windows, cupboards, dressers, stairs, and all the interior fitments for a building.

Timber is the basic material used for any class of wood working. The term 'timber' is applied to the trees which provide us with wood. Wood is one of the most valuable bio-degradable raw materials of industry and daily uses. It is available in a wide choice of weights, strength, colours and textures. Wood is having good machining characteristics and can be sliced, bent, planed, sawed and sanded.

10.2 STRUCTURE OF WOOD

The trees are known as outward growers, due to the fact that each year a new layer of tissue is formed on the outside of previous layers. The layers are termed *annual rings*, because most trees produce one ring each year. Each annual ring is composed of an open porous layer known as springwood, due to the rapid growth in spring, and a thinner denser layer called autumn wood, due to the slowing down of the growth in late summer and autumn. In spring the outer rings of the tree known as *sapwood* convey the watery sap from the roots up to the leaves. Here it undergoes certain chemical changes, and on its return journey to the roots in autumn, this perfected sap leaves behind various starchy secretions, gums, or resins, according to the type of tree. These substances fill up the tissues, feed the tree, and help to form a denser wood known as Doormen or *heartwood*. The cambium layer situated between the sapwood and the bark is responsible for the formation of new wood each year. It divides up, forming a layer of new wood cells on the inside and a soft layer on the outside which becomes bark. Each year the innermost layer of sapwood becomes transformed into heartwood. Fig. 10.1 shows the cross section of a log.

It is generally understood that heartwood is the only part of the tree which should be converted for use, as sapwood is more prone to attack from wood-destroying organisms. If sapwood is properly treated with an effective preservative, it is as durable as heartwood, similarly treated, when used under conditions favourable to decay. The difference in colour between sapwood and heartwood is most important when choosing wood for joinery, the decorative value of which depends on the dark colour and grain of the heartwood. Treating with preservatives is useless and staining is very difficult, as sapwood absorbs stain more readily than heartwood and takes on a much darker shade. Therefore, for all joinery work it is better that sapwood be eliminated altogether.

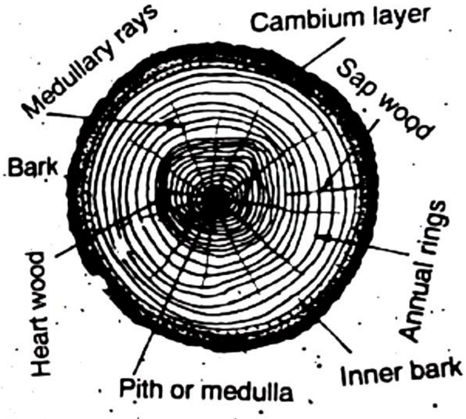


Figure 10.1 Cross section of a log

10.5 CLASSIFICATION OF WOOD

Timbers, for commercial purposes, are divided into two classes : (1) soft wood, and (2) hard wood. These two terms however, have no reference to the hardness of the wood and they are only two botanical classifications.

Soft woods belong to conifers which have long narrow leaves. They contain turpentine and resinous matters in their cells. The average soft-wood contains about 42 per cent cellulose, 25 per cent hemicellulose, 30 per cent lignin and 3 per cent miscellaneous items. Lignin also known as 'wood glue' holds the other items together in the wood. It can be converted into vanillin or other resinous materials useful for foundry mould. Soft woods are light in weight and light coloured, have distinct annual rings but no visible medullary rays, and the colour of the sapwood is not distinctive from their heartwood. The fibres are generally coarse but straight, and hence, capable of resisting direct axial stresses ; but they cannot resist any kind of stress developed across their fibres and the timber gets splitted easily.

Hard woods belong to board-leaved trees. An average hard-wood consists about 45 per cent cellulose, 25 per cent hemicellulose, 23 per cent lignin and 7 per cent miscellaneous items. The annual rings are more compact, thin and less distinct, but the medullarly rays are visible in most, and in some cases very pronounced. Hard woods are darker in colour, comparatively heavy, the fibres are fine grained, compact, properly bonded, and often found very straight. So hard woods are nearly equally strong both along and across the fibres and can resist axial stress as well as transverse strain, shock and vibration quite satisfactorily.

Non-resinous or hard woods like Sal, Pyingads and Ash, which do not readily catch fire, are sometimes classed as *refractory* ; and the resinous or soft wood like Deodar. Pine, and Fir, which readily catch fire and burn because of the presence of resinous matter, are classed as *non-refractory*.

10.4 SEASONING OF WOOD

The advantages of seasoning are that it makes the timber lighter in weight , more resilient, and less liable to twist, warp, and split. It is also in a better condition to retain its size and shape after being made into a piece of joinery.

Seasoning of timber is the process whereby the surplus moisture is drawn from the green timber by evaporation, thus allowing the natural juices to harden. The trees are felled when reaching maturity and the logs roughly squared into *balks*. The best method is to stack the balks under cover, so that a free circulation of air is provided all round them.

This method, known as *natural seasoning*, is slow, but gives the best results, A further period of seasoning should take place after the balks are sawn up and converted into planks or boards. This is to help dry out the interior of the timber which has been exposed by sawing.

As the moisture evaporates during seasoning, shrinkage of the timber takes place .If a balk is dried too quickly, splits and cracks will appear. Shrinkage in the length is negligible, but is more pronounced in the direction of the annual rings.

Sapwood shrinks more than *heartwood*, so that a board cut from the outside of a log will shrink more, and have a greater tendency to warp, than one cut from the centre.

...thod the period of seasoning is very

than one cut from the centre.

In the *artificial seasoning* method, the period of seasoning is very much reduced, a matter of two or three weeks being sufficient according to the size or species of timber to be seasoned .The timber is stacked on a special truck and wheeled into a chamber which is then sealed. Hot air is circulated by fans, and a certain amount of steam is added in order to retain the correct humidity. Samples are tested at intervals to ascertain the percentage of moisture remaining in the timber. Seasoned timber still contains a proportion of moisture, which varies from 16 to 22 per cent according to the atmospheric conditions, and this need not be dried out any further if intended for use out-of-doors.

If used for interior work or in a heated atmosphere, the timber should be further conditioned, that is, dried in warm-air kilns, or stored in a similar atmosphere to that in which it will be fixed, until the moisture contents is brought down to the region of 8-12 per cent .

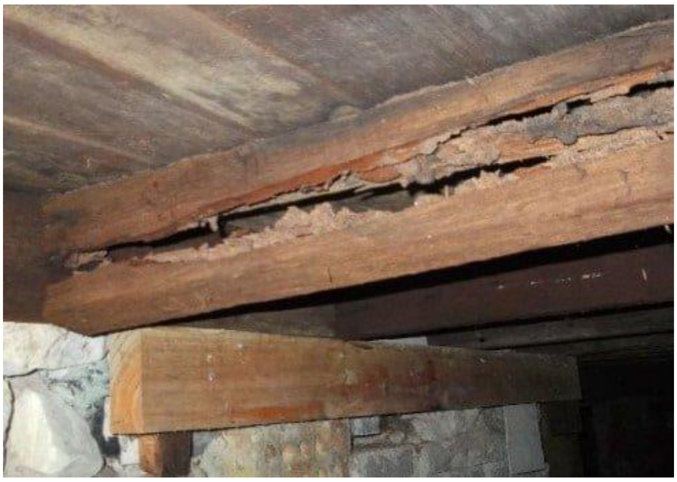
Moisture content is the amount of water in a sample, expressed as a percentage of the dry weight of the wood sample itself.

Timber which has been stored in a damp atmosphere should not be converted into a piece of joinery and then fitted into a warm room . The result will be rapid shrinkage, warping, twisting and splitting.

TIMBER PRESERVATION

Preservation of timber is carried out to increase the life of timber. Preservation is done using different types of preservatives. Methods and different materials used for preservation of timber are discussed.

Increasing life makes timber more durable and it can be used for longer periods. Preservation also helps the timber to get rid of insects and fungi etc. If preservation is not done, then wood will be diseased and damaged badly as shown in figure below.



Different Types of Preservatives for Timber

- Coal tar
- Chemical slats
- Oil paints
- Solignum paints

Coal Tar for Preservation of Timber

Coal tar is heated and obtained liquid hot tar is applied on timber surface using brush. Coal tar contains unpleasant smell and does not allow paint on it.
So, it is used for door frames, window frames etc. It is very cheap and has good fire resistance.

Chemical Slats for Preservation of Timber

Chemical salts like copper sulphate, mercury chloride and zinc chloride are used as preservative which can be dissolved in water to get liquid solution. They are odourless and do not generate flames when contact with fire.

Oil Paints Preservatives for Timber

Oil paints are suitable for well-seasoned wood. They are generally applied in 2 or 3 coats. An oil paint prevents timber from moisture. If timber is not seasoned, then oil paints may lead to decay of timber by confining sap.

Solignum Paints for Preservation of Timber

Solignum paints are applied in hot condition using brush. They are well suitable for preserving timber from white ants. Solignum paints can be used by adding color pigments so, the timber has good appearance.

Methods of Timber Preservation

- Brushing
- Spraying
- Injecting under pressure

- Dipping and stepping
- Hot and cold open tank treatment

Brushing of Timber Preservatives

Brushings the simplest method of applying preservatives. For well-seasoned timber, oil type preservatives are applied with good quality brushes.
For better results, the applied preservative should in hot condition. Multiple coats should be applied and certain time interval should be maintained between successive coats.

Spraying of Timber Preservatives

Spraying is an effective technique than brushing. In this case, preservative solution is sprayed on to the surface using spray gun. It is time saving and quite effective.

Preservative Injecting Under Pressure

The preservative is injected into the timber under high pressure conditions. Generally, creosote oil is applied in this manner which is already discussed above. It is costly treatment process and required special treatment plant.

Dipping and Stepping Method of Timber Preservation

Dipping is another type of preserving in which, timber is dipped directly in the preservative solution. Hence, the solution penetrates the timber better than the case of brushing or spraying.

In Some case, the stepping or wetting of timber with preservative solution is allowed for few days or weeks which are also quite effective process.

Hot and Cold Open Tank Treatment of Timber

In this method, the timber is placed in an open tank which contains preservative solution. This solution is then heated for few hours at 85 to 95 degree Celsius.

Then, the solution is allowed to cool and timber gets submerged with this gradual cooling. This type of treatment is generally done for sap wood.

MISCELLANEOUS MATERIAL USED IN CARPENTRY SHOP

Nails

Nails in wood work are made out of drawn wire of brass or copper or low carbon steel or malleable iron rods. Nails made from drawn wires are termed as wire nails and are produced from rods as clasp nails. The clasp nails possess a better holding capacity than wire nails. According to the use, the wire nails are subjected to light and medium work while the clasp nails are commonly used for heavy work. Nails are mainly used for reinforcing glued joints and fastening different component of woods. Their size is specified by length and diameter. These are sold by weight in the market.

Screws

Screws are made from bright drawn wires or thin rods and they are used mainly for fixing the metallic fittings like hinges and hasps in wooden structure.

Adhesives

Adhesives is defined as the sticking substance such as glue, paste, cement and mucilage that is capable of holding wooden parts together by surface attachment permanently. It is commonly used to join together the boards edge-to edge to form a larger surface or face-to face to increase the thickness. It is applied on large surface areas of material as when laying veneers and is also used to stick together relatively small surface areas such as wood working joints. An efficient adhesive or sticking paste or glue is one that maintains good bond between the wooden elements under the conditions of service that the joint has to withstand. It is required frequently for joining together the wooden boards edge to edge to form a larger surface or face to face to increase thickness in joinery work and many other common types of wood works. It is applied either cold or hot condition. The former is known as liquid or cold glue and is used when a slow and less strong setting is desired. When applied hot, it is known as cooked glue that enables a very strong and permanent type of joint between the adjacent layers of wood pieces. Few commercially available adhesives can be classified as animal glue, vegetable glue, synthetic resins, paint and varnishes, rubber cement and plastic cement.

Paint and varnishes

They are commonly applied on wooden or metallic articles for the reasons to protecting the surfaces of wood or metal from the effects of moisture and weather change. They are used on surfaces for making them decorative in appearance.

10.8 CARPENTRY TOOLS

In order to successfully work different forms to accurate shapes and dimensions, the wood-worker must know the use of a large number of tools. The principal types which are manipulated by hand are described and illustrated below :

1. Marking &measuring tools.
2. Cutting tools.
3. Planing tools.
4. Boring tools.
5. Striking tools.
6. Holding & miscellaneous tools.

10.9 MARKING AND MEASURING TOOLS

Marking and measuring tools have been developed in order that true and accurate work may be assured. The commonest of such tools are :

Rules. Rules of various sizes and designs are used by wood workers for measuring and setting out dimensions, but they usually work with a *four-fold box-wood rule* ranging from 0 to 60 cm. This is graduated on both side in millimetres and centimetres, and each fold is 15 cm long. All the four pieces are joined with each other by means of hinged joints which make the scale folding.

For larger measurements carpenters use a *flexible measuring rule* or *tape*. Such rules are very useful for measuring curved and angular surfaces. When not in use, the blade is coiled into a small, compact, watch-size, case.

Straight edge. The straight edge (Fig. 10.2) is a machined flat piece made of wood or metal having truely straight and parallel edges. One of the longitudinal edges is generally made leveled. This is used to test the trueness of large surfaces and edges.

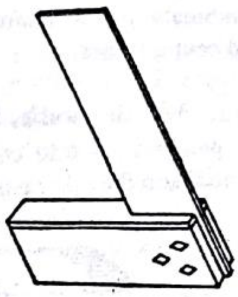


Figure 10.3 Try square

Try square. Try squares (Fig. 10.3) are used for marking and testing angles of 90°. It consists of a steel blade, riveted into a hard wood stock which has a protective brass plate on the working surface. Another type is the all-metal square, with steel blade and cast iron stock. Sizes vary from 150 to 300 mm, according to the length of the blade.

Marking knife. Marking knives (Fig. 10.6) are used for converting the pencil lines into cut lines. They are made of steel having one end pointed and the other end formed into a sharp cutting edge.

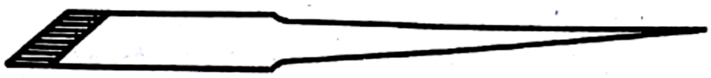


Figure 10.6 Marking knife

Gauges. Gauges are used to mark lines parallel to the edge of a piece of wood. It consists of a small stem sliding in s stock. The stem carries one or more steel marking points or a cutting knife. The stock is set to the desired distance from the steel point and fixed by the thumbscrew. The gauge is then held firmly against the edge of the wood and pushed along the sharp steel point marking the line.

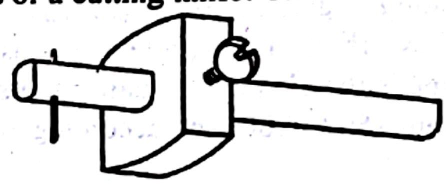


Figure 10.7 Marking gauge

The *marking gauge* (Fig. 10.7) has one marking point. It gives an accurate cut line parallel to a true edge, usually with the grain. The *panel gauge*, is longer than the marking gauge, and is used to gauge lines across wider surfaces.

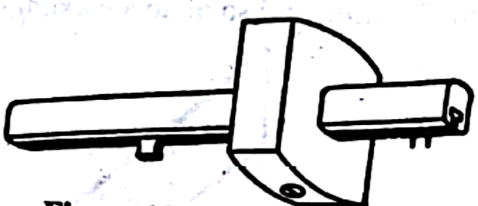


Figure 10.8 Mortise gauge

Wing compass. Wing compasses are composed of two finely pointed steel legs which are set to the desired position and held by a set screw and quadrant. They are used when stepping off a number of equal spaces, marking circles or arcs, and when scribing parallel lines to straight or curved work.

Divider. Dividers have both points sharpened in needlepoint fashion for dividing out centres.

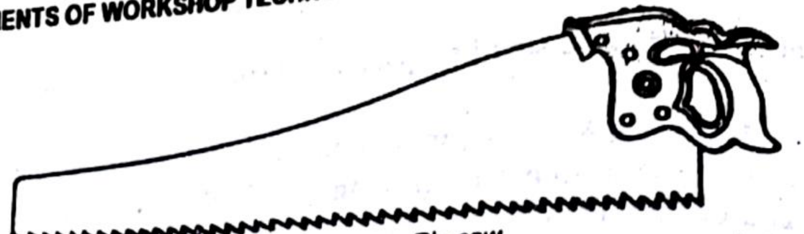
Caliper. Calipers are used for measuring outside and inside diameters, etc., especially where the sectional measurements cannot be taken.

10.10 CUTTING TOOLS

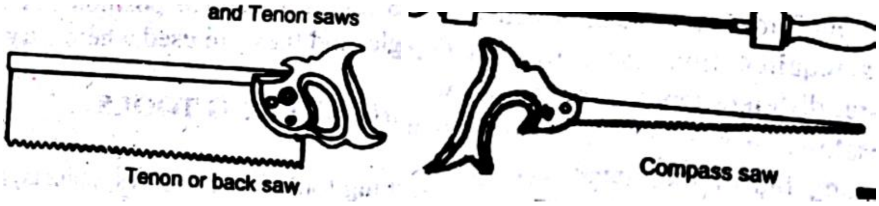
Cutting tools include saws, chisels, and gouges.

Saws. The saw is probably the most abused of woodworking tools, chiefly because inexperienced users force it too much. When cutting across the grain, a different action is required from the saw teeth than when ripping with the grain. Therefore, different types of saws are used, as one type cannot do both jobs successfully. A saw is generally specified by the length of its blade measured along the toothed edge, and pitch of teeth, expressed in millimeters. Fig. 10.10 shows the different types of saws in common use.

Rip saw. Rip saws are used for cutting along the grain in thick wood. The blade is made of high grade tool steel, and may be either straight or skew backed. It is fitted in a wooden handle made of hard wood by means of rivets or screws. Rip saws are about 700 mm long with 3 to 5 points or teeth per 25 mm.



Rip saw



Tenon or back saw. This saw is mostly used for cross-cutting when a finer and more accurate finish is required. The blade, being very thin, is reinforced with a rigid steel back. Tenon saw blades are from 250 to 400 mm in length and generally have 13 teeth per 25 mm. The teeth are shaped in the form of an equilateral triangle and are sometimes termed "peg" teeth.

Compass saw. The compass saw is used for sawing small curves in confined spaces and has a narrow tapering blade about 250 to 400 mm long, fixed to an open-type wooden handle. There are two types of compass saw, one having a fixed blade and the other with three interchangeable

blades of different widths.

Chisels. Wood chisels most commonly in use include firmer chisels, either square of bevel edged, paring chisels, and mortise chisels. They are usually specified by length and width of the blade.

Firmer chisel. The firmer chisel shown in Fig. 10.11 is the most useful for general purposes and may be used by hand pressure or mallet. It has a flat blade about 125 mm long. The width of the blade varies from 1.5 to 50 mm.

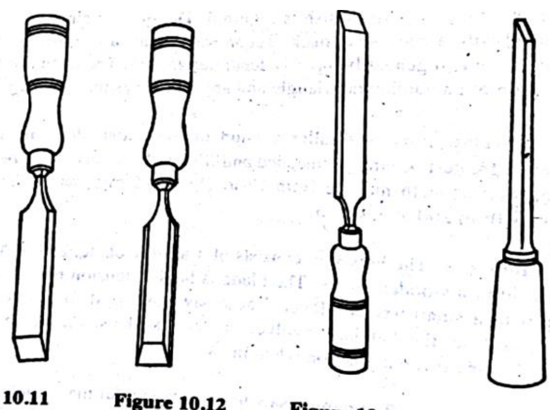


Figure 10.11 Firmer chisel

Figure 10.12 Bevelled edge firmer chisel

Figure 10.13 Paring chisel

Figure 10.14 Mortise chisel

Bevelled edge firmer chisel. The bevelled edge firmer chisel illustrated in Fig. 10.12 is used for more delicate or fine work. They are useful for getting into corners where the ordinary firmer chisel would be clumsy.

Paring chisel. Both firmer and bevelled edge chisels when they are made with long thin blades are known as paring chisel (Fig. 10.13). This is used for shaping and preparing the surfaces of wood and is manipulated by the hands. The length ranges from 225 to 500 mm and width from 5 to 50 mm.

Mortise chisel. The mortise chisel shown in Fig. 10.14, as its name indicates, is used for chopping out mortises. These chisels are designed to withstand heavy work. They are made with a heavy deep (back to front) blade with a generous shoulder or collar to withstand the force of the mallet blows on the oval-sectioned handle. Many mortise chisels are fitted with a leather washer at the shoulder to absorb the hard shocks of the mallet blows. Blades vary in width from 3 to 16 mm.

10.11 PLANES

The plane can be likened to the chisel fastened into a block of metal or wood, and its blade cuts exactly like a wide chisel. The planes, in general use, are the jack, trying, and smoothing planes, and are known as bench planes. Besides, there are other planes which are used for special work.

Jack plane. A jack plane shown in Fig. 10.16 is the commonest and is used for the first truing-up of a piece of wood.

It consists of a block of wood into which the blade is fixed by a wooden wedge. The blade is set at an angle of 45° to the sole. On the cutting blade another blade is fixed called cap iron or back iron. This does not cut, but stiffens the blade near its cutting edge to prevent chattering and partially breaks the shaving as it is made. It is the back iron which causes the shavings to be curled when they come out of the plane. Some types of planes do not have a cap iron. Jack planes are obtainable from 350 to 425 mm in length and with blades 50 to 75 mm wide.

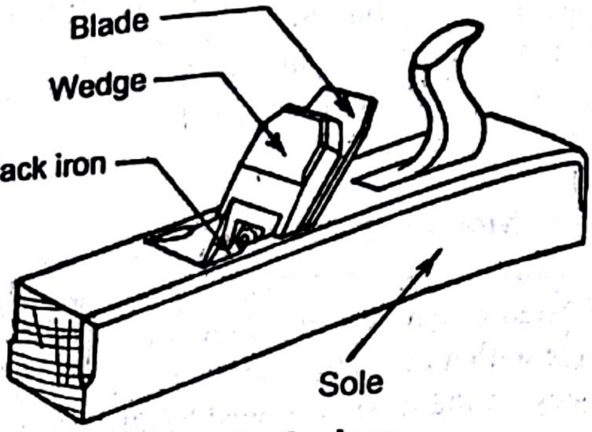


Figure 10.16 Jack plane

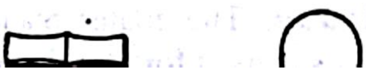
Metal plane. Metal planes serve the same purpose as the wooden planes but facilitate a smoother operation and better finish. The body of a

metal plane is made from a grey iron casting, with the side and sole machined and ground to a bright finish. The thickness of the shaving removed is governed by a fine screw adjustment , and a lever is used for adjusting the blade at right angles. A metal jack plane us shown in Fig. 10.23

Figure 10.23 Metal jack plane

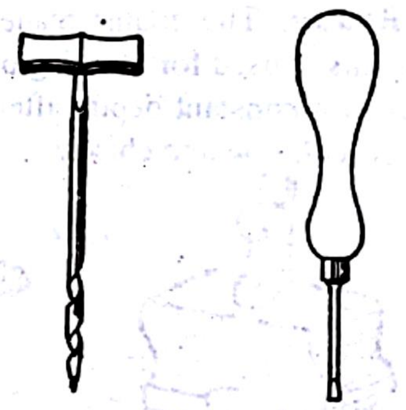
10.12 BORING TOOLS

Boring tools are frequently necessary to make round holes in wood, and they are selected according to the type and purpose of the hole. They include bradawl, gimlet, brace, bit and drill.



include bradawl, gimlet, brace, bit and drill.

Bradawl and gimlet. The bradawl and the gimlet illustrated in Fig. 10.24 are hand-operated tools, and are used to bore small holes, such as for starting a screw or large nail.



Gimlet *Bradawl*

Figure 10.24 Bradawl & gimlet

Brace. The brace is a tool used for holding and turning a bit for boring holes. It has two jaws, which grip the specially shaped end of the bit. There are two types of braces in common use – ratchet brace and wheel brace. The *ratchet brace* is most useful for turning bits and drills of all kinds, being adaptable (a) for working in confined situations, and (b) for when the cut is particularly heavy and it is desirable to pull the handle through a quarter-turn only. A ratchet brace is shown in Fig. 10.25.

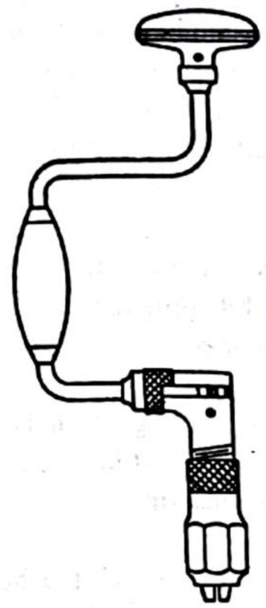


Figure 10.25 Rachet brace

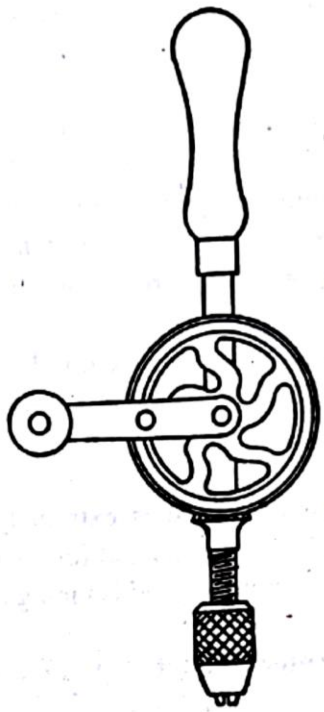
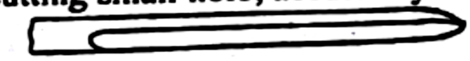


Figure 10.26 Wheel brace

Figure 10.25 Rachet brace

The *wheel brace* (Fig. 10.26) is used to hold round and parallel-shanked drills. This tool is invaluable for cutting small hole, accurately and quickly.



Reamer

Bit. Most other forms of boring tools consist of "bits". The common types of bits used are shown in Fig. 10.27 and described below :

Shell bit. This bit is used for boring holes unto 12 mm diameter and which do not require a high degree of finish or size.

Twist bit or auger bit. It has a screw point and a helical or twisted stem. This bit produces a long, clean, and accurate hole either with or across the grain. This may be obtained in sizes from 6 to 35 mm diameter. The shorter type is called "dowel" bits and is used for preparing true and accurate holes to receive dowels.

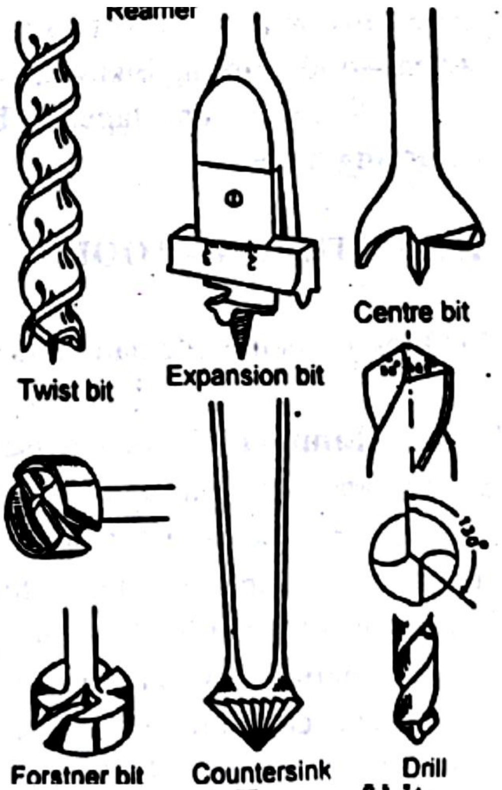


Figure 10.27 Types of bits

10.13 STRIKING TOOLS

Striking tools include hammers and mallets.

Hammer. Engineers use ball-peened hammers, woodworkers cross-peened and claw hammers. The *Warrington hammer* shown in Fig. 10.29 is the type mostly used for bench work and all light Jobs. The head is cast steel, the face and peen being tempered ; the shaft which is wedged tightly into the head is made of wood or bamboo. These hammers are identified by size numbers and weight, No: 00, 200 gm upto No. 6,550 gm.

The carpenter more often favours the *claw hammer* (Fig. 10.28) because it serves the dual purpose of a hammer and a pair of pincers. The claw is used for pulling out any nails accidentally bent in driving. These hammers are made in numbers sizes from 1 to 4, weighing 375, 450, 550 and 675 gm.

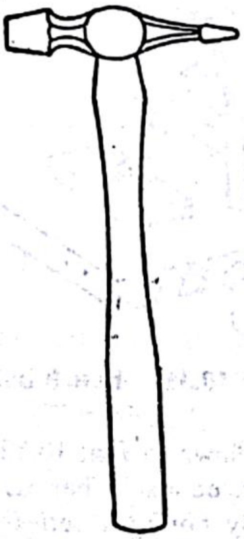


Figure 10.28 Warrington hammer

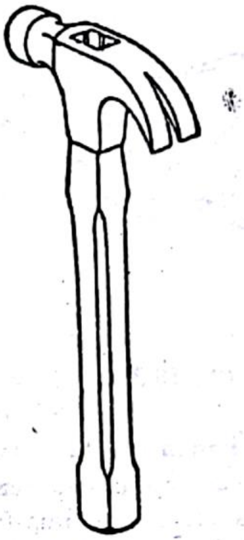


Figure 10.29 Claw Hammer

Mallet. The mallet shown in Fig. 10.30 is a wooden-headed hammer of round or rectangular cross-section. The striking face is made flat to the work. A mallet is used to give light blows to the cutting tools having wooden handle such as chisels, and gouges.

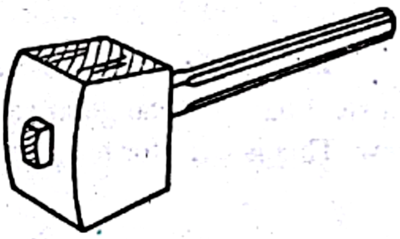


Figure 10.30 Mallet

10.14 HOLDING TOOLS

To enable the woodworker to cut his wood accurately, it must be held steady. There are a number of tools and devices to hold wood, having its own purpose according to the kind of cutting to be done.

Bench vice. The bench vice illustrated in Fig. 10.31 is [illegible] most commonly used. Its one jaw is fixed to the side of the table wh[illegible] other is kept movable by means of a screw and a handle. The whole [illegible] made of iron and steel, the jaws being lined with hardwood face [illegible] do not mark and which can be renewed as required.

Bench stop. The bench stop is simply a block of wood projecting above the top surface of the bench. This is used to prevent the wood from moving forward when being planed.

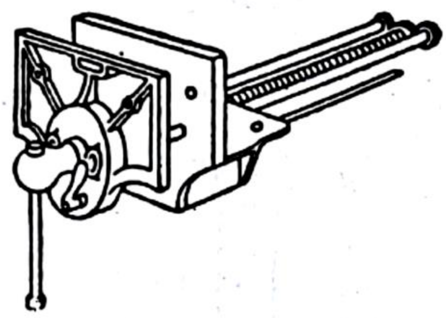


Figure 10.31 Bench vice

Sash cramp. The sash cramp or bar cramp in Fig. 10.33 is made up of a steel bar of rectangular section, with malleable iron fittings and a steel screw. This is used for holding wide work such as frames or tops.

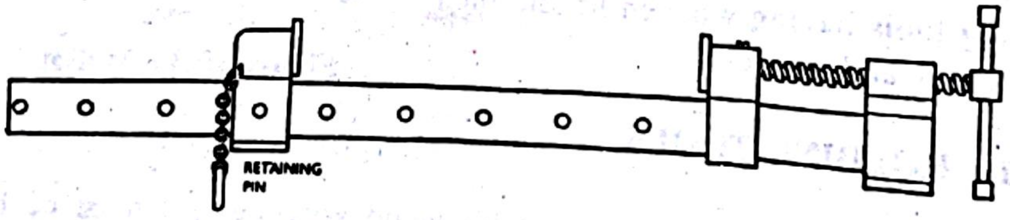


Figure 10.33 Sash cramp

G-cramp. The G-cramp in Fig. 10.34 is used for smaller work. It consists of a malleable iron frame that can be swivelled and a steel screw to which is fitted a thumbscrew.

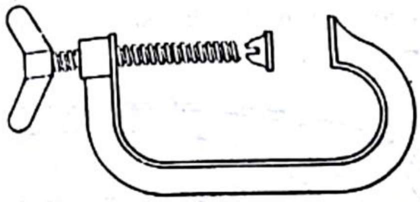
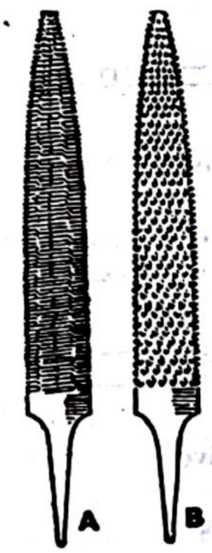


Figure 10.34 G-cramp

10.15 MISCELLANEOUS TOOLS

Rasps and files. These are useful for cleaning up some curved surfaces. For instance, certain concave shapes are so small that the spokeshave cannot enter them and here a file is invaluable. Scratches left by the file can be removed with the scraper and glass paper. Illustration are given in Fig. 10.36.



glass paper.

Scra
(or, more a
off the woo
of a piece c
A fine the
burnishing
what is call

Figure 10.36 Rasp and file

10.17 CARPENTRY PROCESSES

Carpentry and joinery work involve a number of hand operations to finish the work to the desired shape and size with required accuracy. The following is the principal processes used in wooden construction :

1.	Marking.	5.	Boring.
2.	Sawing.	6.	Grooving.
3.	Planing.	7.	Rebating.
4.	Chiselling.	8.	Moulding.

10.18 MARKING

Marking is the process of setting out dimensions on a piece of wood for producing the required shape. These dimensions can be measured from an existing model or can be set out from the drawing prepared for the purpose. Each dimension is taken out with a folding rule which is the most convenient for general use, and is set out with the help of various instruments such as caliper, try-square, marking knife, marking gauge, etc. When marking a size the pieces are first planed true and square and then marked according to the desired dimension. The trueness of the surface is tested every time with the straight edge or the blade of the try-square or the steel rule. A zig-zag pencil mark is made on the true surface to distinguish it from the other faces.

10.19 SAWING

Sawing is one of the basic operations carried out in a carpentry shop. A wood is required to be sawn along the grains or across the grains and in many shapes such as straight inclined or curved. To start the cut, the thumb of the left hand is placed against the blade. This steadies the blade, enabling it to start in the right place, and prevents any accident in the event of the saw jumping. One or two short movements are first given, taking care that the saw works in the right direction and then full, easy strokes are applied to cut the wood. A point to note in all sawing is that the cut is made on one side of the line already marked and that is on the waste side, as in Fig. 10.44. A saw should never be forced and it is kept moving steadily for nearly its full length. Its own weight plus the slightest pressure is all that is needed.

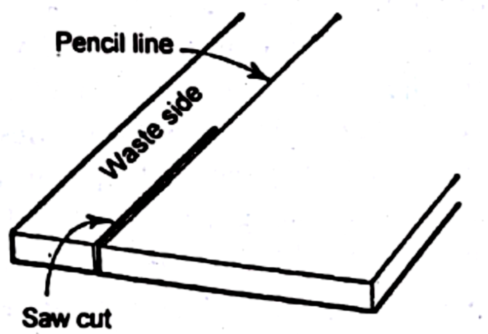


Figure 10.44 Sawing to pencil line

10.20 PLANING

Planing is the operation of truing up a piece of wood by a planer. This is known as "facing and edging", and the future success of most pieces of work is dependent on this preliminary operation being properly carried out. A properly planed surface should be perfectly straight in all directions, parallel in width and thickness, and with edges square to the face. This is achieved by carrying out the following sequence of operations.

First choose what apparatus to be the best face. Next plane off the rough surface with the jack plane, taking off as little as possible, but at the same time attempting to plane the surface by taking more off the high parts.

Each time the pressure is applied on the forward stroke and relieved on the return stroke. At the start of the stroke, maximum force is applied to the handle for driving the plane. This force is balanced by pressing the other hand on the tip. For heavy work the pressure on the tip is applied with the palm of the hand, but for light work the tip is held in hand with the thumb on the top and the two centre fingers at the bottom of the sole. As planing proceeds, the material should be checked to see if it is straight across the face. This may be done with a try-square or by using the edge of the jack plane.

10.21 CHISELLING

Chiselling is the process of cutting a small stock of wood to produce the desired shape.

To cut horizontally *with* the grain the chisel is held slightly tilted to one side and pushed forward in the direction of the grain. For roughing down to size, the bevel side is down ; for the finish cut the bevel side is up. To chisel horizontally *across* the grain, the work is clamped in the vice. The blade of the chisel is grasped with the thumb and forefinger to act as a brake. The handle is slightly lowered down and chiselled from both sides to avoid splintering the corners. With the chisel held flat the high spot in the centre is removed. In vertical chiselling across the grain the chisel is controlled with the left hand pressing firmly on the blade of the chisel and resting on the wood. The chisel is tilted slightly to one side to give a shearing cut. In rounding or shaping a corner, chiselling should commence at the edge of the board and work round to the end, that is, with the grain, otherwise the corner of the chisel will bite into the grain and split the wood. Firmer chisels are used for heavier work and should be hit with the mallet ; in fact, the mallet should be used on all chisels and gouges whenever necessary.

10.22 BORING

Boring is the process of producing round holes, through or blind, in the wood. This boring can be done straight or inclined to suit the type of work. While boring, the work is firmly secured in a holding tool in order to avoid

production of an eccentric hole. Small holes can be made by using a bradawl and gimlet, but large holes require braces and bits or drills. These bits and drills should be turned constantly in one direction and withdrawn at intervals, to remove the waste core, by turning in the apposite direction and exerting an upward pull. When using the brace and twist bit to bore rather deep holes. the direction of the bit should be carefully checked at the start. The bit should be guided by sighting either with the try square or small straight edges. The operator must stand in a suitable position while boring in order to do this sighting. Correct marking and location of the centre are also very important to produce a hole of the correct size.

10.23 GROOVING

The grooving is a term which is almost always used with the term tongueing. These are operations of making grooves and tongues that are usually cut on the edges of planks and boards to join them together to form big boards of large width. A groove is a channel cut to any shape, and a tongue is the corresponding projection formed to fit into it. Actual application of grooves and tongues can very well be seen in drawing boards, floor boards, wall partitions and in other articles where considerably large sizes are needed. The groove is cut with a plough plane, and a tongue with tongueing plane or a moulding plane.

10.26 CARPENTRY JOINTS

Constructional woodwork can be divided into two main classes : framework and carcase work. In framework, typical joints used, are the various *halving joints, mortise* and *tenon joints,* and *bridle joints.*

Carcase work is characterized by box-like shapes of solid wood or laminboard. Typical joints used, are *butt* or *rubbed joint*, *dowel, tongue and groove*, and the *screw* and *slot joint* ; other joints include *dovetail joints*, and *corner joints*.

Before any joints can be attempted it is necessary to prepare the stuff. This means planing the wood to size and getting four true surfaces.

Halving joint. The aim of this joint is to secure the corners and intersections of the framing, and at the same time keep all the face flush, that is, in the same plane. The halving joint, also termed a *half-lap joint*, may be usefully employed in many types of framing where strength and appearance are of secondary consideration. Various forms of halving joint are shown in Fig. 10.45.

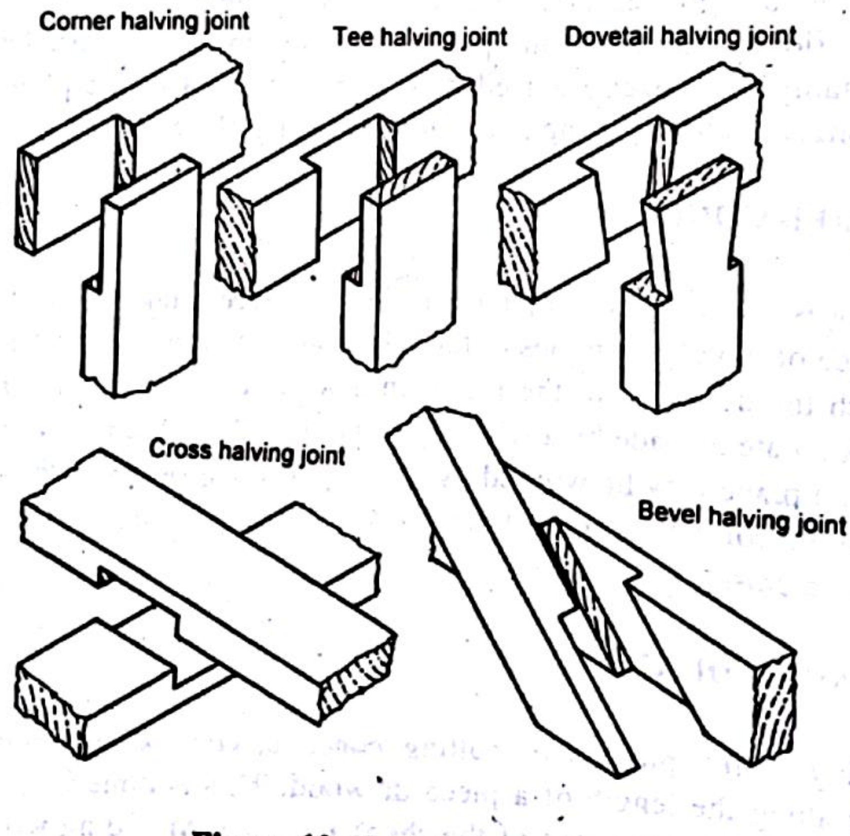


Figure 10.45 Halving joints

Mortise and tenon joint. This family of joint is a large one and is probably the commonest used by the woodworker. It consists of a rectangular peg (tenon) fitting into a rectangular hole (mortise). Various forms of mortise and tenon joints are illustrated in Fig. 10.46.

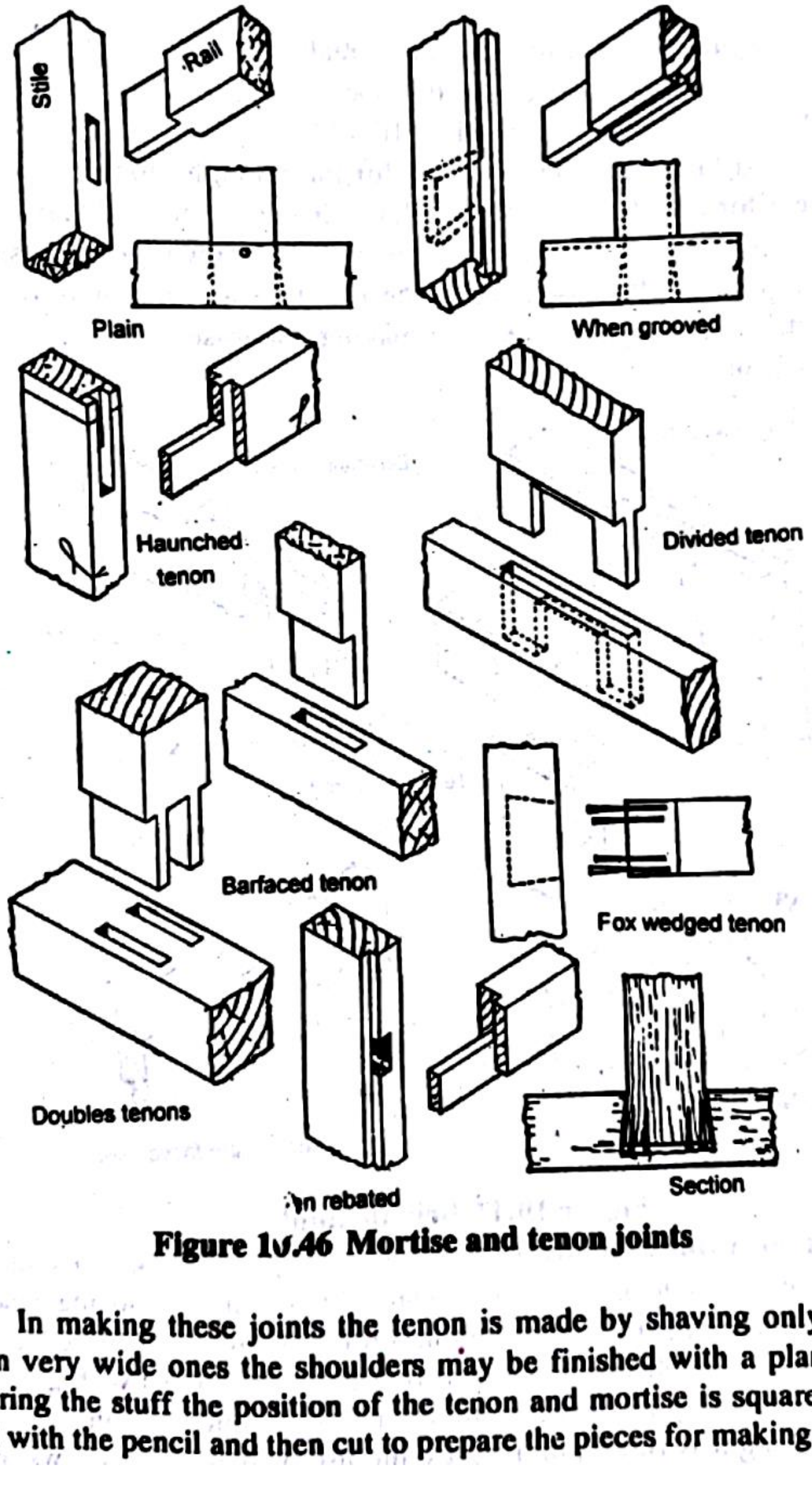


Figure 10.46 Mortise and tenon joints

In making these joints the tenon is made by shaving only, except that in very wide ones the shoulders may be finished with a plane. After preparing the stuff the position of the tenon and mortise is squared on the wood with the pencil and then cut to prepare the pieces for making joints .

Two tools have been developed solely for making the joints : (1) mortise chisel, and (2) mortise gauge. For general framing work the width of a mortise is about one-third the thickness of the material to be mortised, and the length should not exceed six times the width.

Butt or rubbed joint. The fastening of boards edge to edge is frequently necessary to give a wider board, for example, drawing board, table top, counter top, etc. The commonest form of edge joint is the butt or rubbed joint (Fig. 10.48) in which two true edges are joined with glue. If properly done, this joint is very strong. For stuff thicker than 25 mm, additional strength is often provided by the use of dowels or screws and slots. The rubbed joint is made by planing the two edges true with a trying plane.

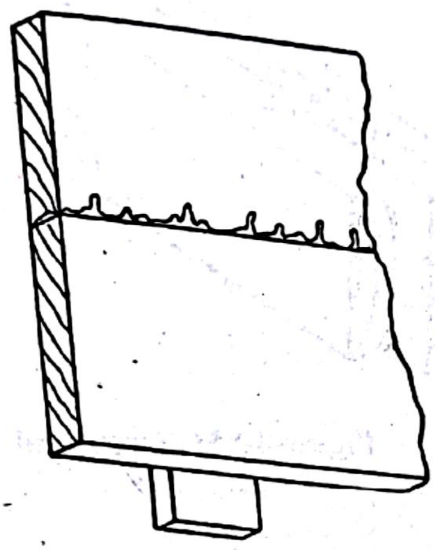


Figure 10.48 Butt of rubbed joints

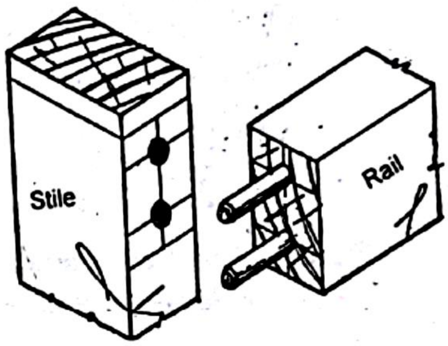


Figure 10.49 Dowel joints

Dowel joint. The dowelled joint is often used as farming joint in the place of the mortise and tenon joint. This may be used to advantage in many cases, such as the joints in circular work, butt jointing two edges or positioning movable fittings. A typical dowel joint is shown in Fig. 10.49.

Tongue and groove joint. Commercially machined boards for edge to edge jointing, such as drawing boards, floor boards, and match boards, are tongued and grooved. the tongues are used to provide extra support and additional gluing surface. These may be either self-tongues or loose as shown in Fig. 10.50. Self-tongues are prepared by cutting a tongue on one edge and a suitable groove on the other with the aid of a matching plane. In those tongues, both edges are trued and then plough grooved.

Dovetail joint. The dovetail joint is probably the strongest of all corner joints. It was primarily a joint intended to take a strain in one direction, but it has several variations and many applications, particularly in making box or carcase-like constructions—form small boxes to large pieces of furniture. Various forms of dovetail joints are shown in Fig. 10.52.

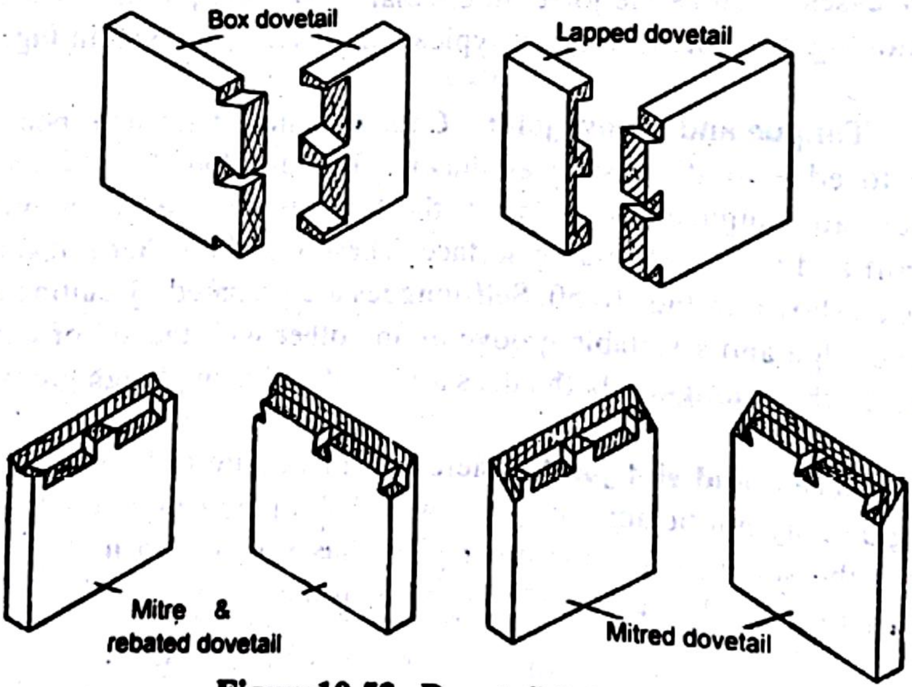


Figure10.52 Dovetail joints

There are two methods of this : one is to cut the pins first and then mark the sockets from them, and the other is to cut the sockets first. In the

first method the marking out may be done neater, but each piece must be delt with separately, whereas by cutting the socket first, a number of pieces may be delt with in one operation, This is perhaps the best method, as the sockets are easier to cut straight and there is saving of time.

Corner joint. There are may ways of joining angles or corners together other than by dovetailing. A few of these are shown in Fig.10.53.

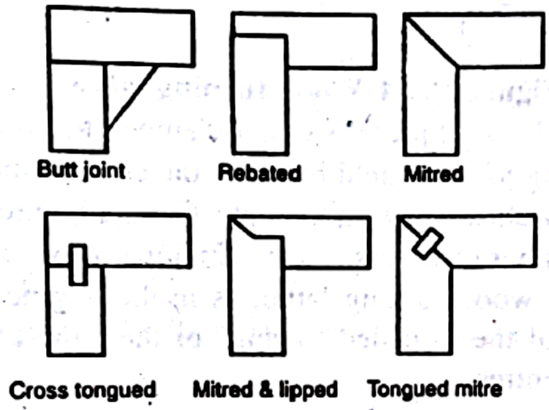


Figure 10.53 Corner joints