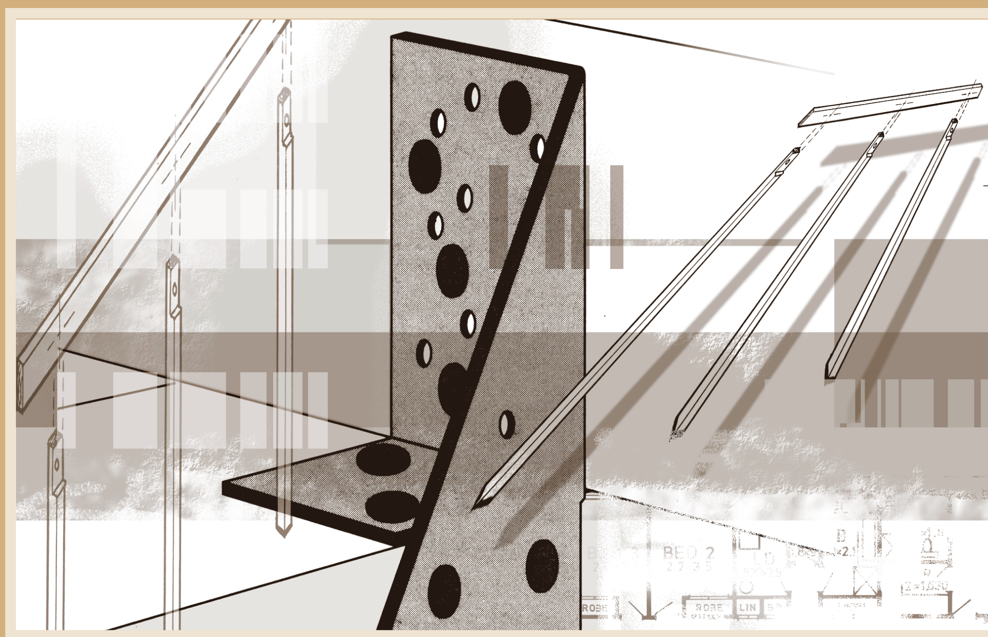
Year 11



Design and Technology

Design & Technology

Year 11

FA'AVAE I LE ATUA SAMOA

GOVERNMENT OF SAMOA
MINISTRY OF EDUCATION, SPORTS AND CULTURE

Acknowledgements

The Ministry of Education, Sports and Culture (MESC), would like to thank Terry Smith for his vision, patience and hard work in putting together this valuable book.

Original drawings by: Terry Smith

They would also like to thank the following companies for allowing reproduction of their material:

Timber Development Association

Makita (Australia) Pty Ltd

Pine Australia

MiTek Australia Ltd

The Complete Book of Woodworking and Carpentry, T.D.Smith and B.E.Haines, Lansdowne Publishing Pty

Technical Drawing, A.W.Boundy and I.L.Hass, McGraw-Hill Book Company

Designed, edited and typeset by Egan-Reid Ltd, Auckland, as part of the Samoa Secondary Education Curriculum and Resources Project for:

Government of Samoa Ministry of Education, Sports and Culture, 2003.

Funded by the New Zealand Agency for International Development,
Nga Hoe Tuputupu-mai-tawhiti.

Printed through Egan-Reid Ltd.

Managing Contractor: Auckland UniServices Limited.

ISBN 982–517–051–4

TABLE OF CONTENTS

Unit 1: DRAWING AND DESIGN

Objectives

At the end of this unit you should be able to:

- Select and use the correct types of lines for your drawings.
- Apply and interpret the correct scales for your drawings.
- Read and interpret architectural type plans and elevations.
- Use correct material representations when drawing architectural plans.
- Design and draw to scale, selected outdoor structures.

Architectural Drawing For Building Construction

Thickness of line	Types of Lines	
0.7 mm		**Outlines** The visible outline should be heavy and dark enough to stand out clearly on the drawing sheet. All of the outline should be the same thickness and darkness.
0.35 mm		**Dimensions and Projection Lines** These should be half the thickness of outlines.
0.35 mm		**Centre Lines** These are broken lines which are made of a short dash and a long dash. They are the same thickness as dimension lines. Centre lines project a short distance past the outline.
0.18 mm		**Hidden Lines** These are thin broken lines made of dashes. They show the outlines of things which are hidden behind what is shown in the drawing. Dashes should meet at corners. For things which are completely hidden, the line should begin and end with a dash.
0.18 mm		**Ruled Zigzag Lines** These lines are used to show a break, where the whole line is not drawn. It may be a break where the object in the drawing is attached to something else which is not shown fully in the drawing. They are also used to indicate a break in a long continuous series of lines on architectural drawings.

Representation Of Materials

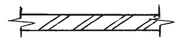
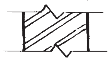
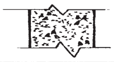
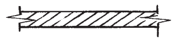
Material	General locations Drawings sections	Large scale Drawing sections
Brickwork		
Concrete		
Concrete block		
Earth		
Structural steel		
Stud walls		

Figure 1.1
Representation of materials.

Scales

A scale shows the ratio between the actual length of lines in a drawing and the true measurement of the real object which is shown in the drawing.

For example: A drawing of a table shows a ratio of 1:10, and the table is 100 mm long in the drawing. The real table is 100 mm × 10, which is 1 metre.

Technical drawings may be prepared full size, enlarged or reduced in size. Whatever scale is used, it is important that the scale is written near the title block. The title block shows the name of the drawing.

The scales for use with the metric system are:	
Full size	1:1
Enlargement	2:1, 5:1, 10:1, 20:1
Reduction	1:2, 1:5, 1:10, 1:20, 1:100

Enlargement Scales
These scales are used when the drawing is bigger than the real object. For example: a 2:1 scale means the lengths in the scale are twice as long as the real length, and twice as long as the real object which will be made from the drawings. In other words, on a 2:1 scale, 1cm real length is drawn 2 cms long.

Reduction Scales
Reduction scales are used when the drawing is smaller than the real object. So a drawing of a whole table, or a whole room in a house, always uses a reduction scale because the real object is too big to fit on a piece of paper.

Architectural Conventions

Dimensioning

Only the dimensions which are necessary for carrying out the work should be shown. The same dimension should not be shown in two places on a drawing. For example, the height of a door is the same on the left and the right. The height should be shown on only one side in the drawing.

Dimension figures should be written in the following way:

- Immediately above the dimension line.
- Parallel with the dimension line.
- Towards the centre of the line, and so that you can read them from the bottom of the sheet of paper, or the right-hand edge of the sheet.

Below shows a floor plan of a residential building. All the dimensions are shown correctly according to architectural conventions for drawings.

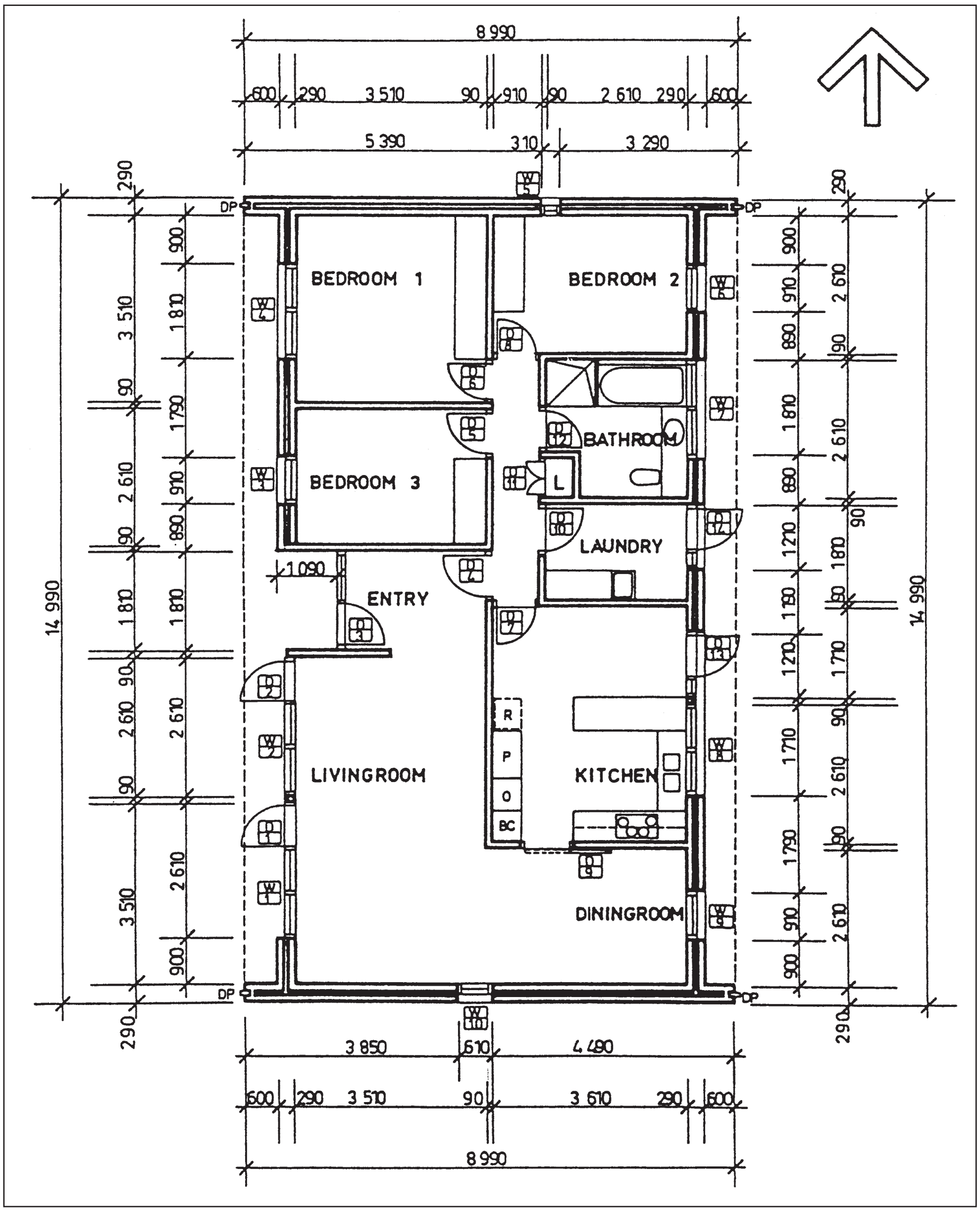


Figure 1.2

Floor plan of a residential building.

Activity 1 Draw A Floor Plan

Figure 1.3 shows the outline of a floor plan for a brick veneer home. Use it to prepare an architectural drawing of a floor plan, using the following information:

Scale 1:100
External walls: 250 mm thick
Internal walls: 70 mm thick
Eaves: 600 mm wide

Windows:	lounge bedrooms 1, 2, 3 dining family kitchen	1200 wide × 1800 high mm
	bathroom ensuite	1000 wide × 1200 high mm
	entrance	900 wide × 1000 high mm
	laundry WC	600 wide × 900 high mm
Doors:	front door backdoor	900 wide × 2100 high mm

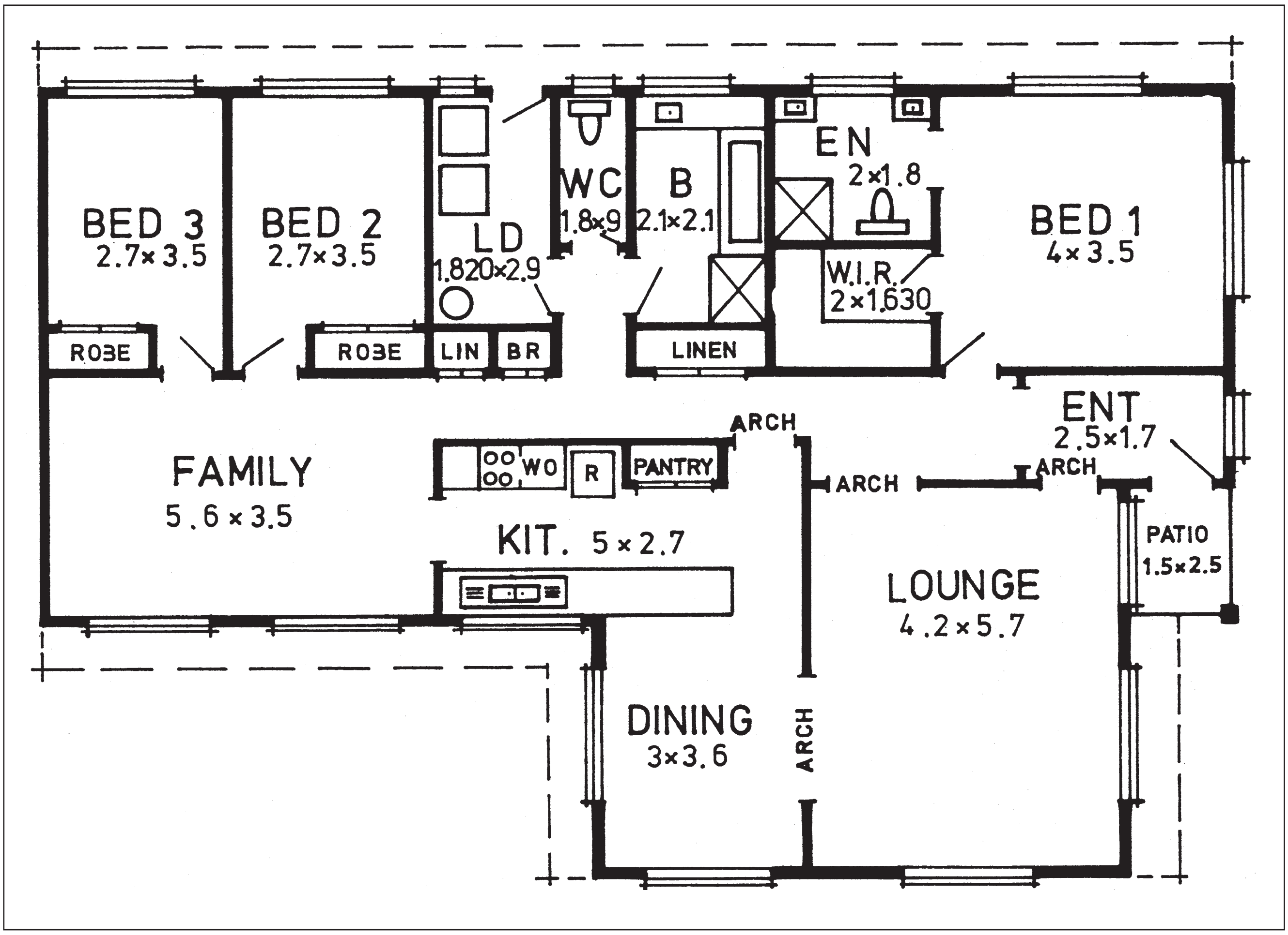


Figure 1.3
Brick veneer home floor plan.

Activity 2 Architectural Drawings Of A Shelter

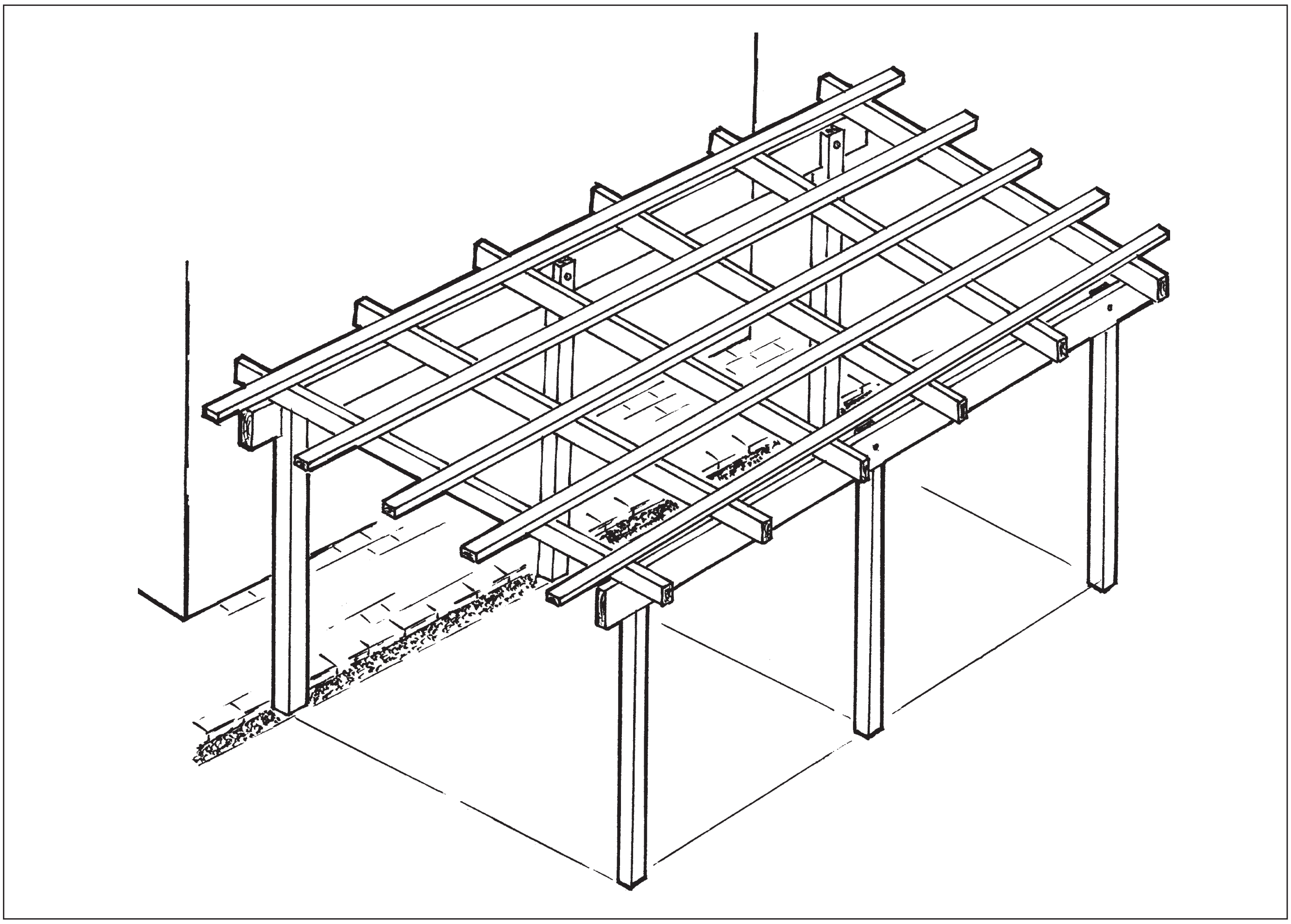


Figure 1.4
Freestanding flat roof shelter.

The illustration above shows a freestanding flat roof shelter. Use it to prepare an architectural drawing of three views of the shelter:

- The left hand view (including footing details).
- The front view.
- The top view.

Use the following information:

Posts fixed to ground using galvanised post anchors. (See Figure 5.4, page 43.)

Beams notched and bolted to posts. (See Figure 7.7, page 64.)

Battens secured to rafters using galvanised nails.

Scale to be 1:50

Posts	90 mm × 90 mm	Height	2.4 m		
Beams	190 mm × 35 mm	Span	2.4 m		
Rafters	140 mm × 35 mm	Spacing	600 mm	Span	3.6 m
Battens	70 mm × 35 mm	Spacing	900 mm		

Activity 3 Architectural Drawings Of Roof Trusses And Rafters

Figure 1.5 shows a freestanding gable roof frame. The roof is removed.

Use the drawing and the information in Table 2, page 59, to prepare an architectural drawing of:

- A roof truss having a span of 3.6 m with a pitch of 22.5°. (See truss details in Figure 7.20, page 75.)
- Rafters to be fixed to beams using joist hangers or similar. (See truss details in Figure 7.20, page 75.)

Use a scale of 1:50

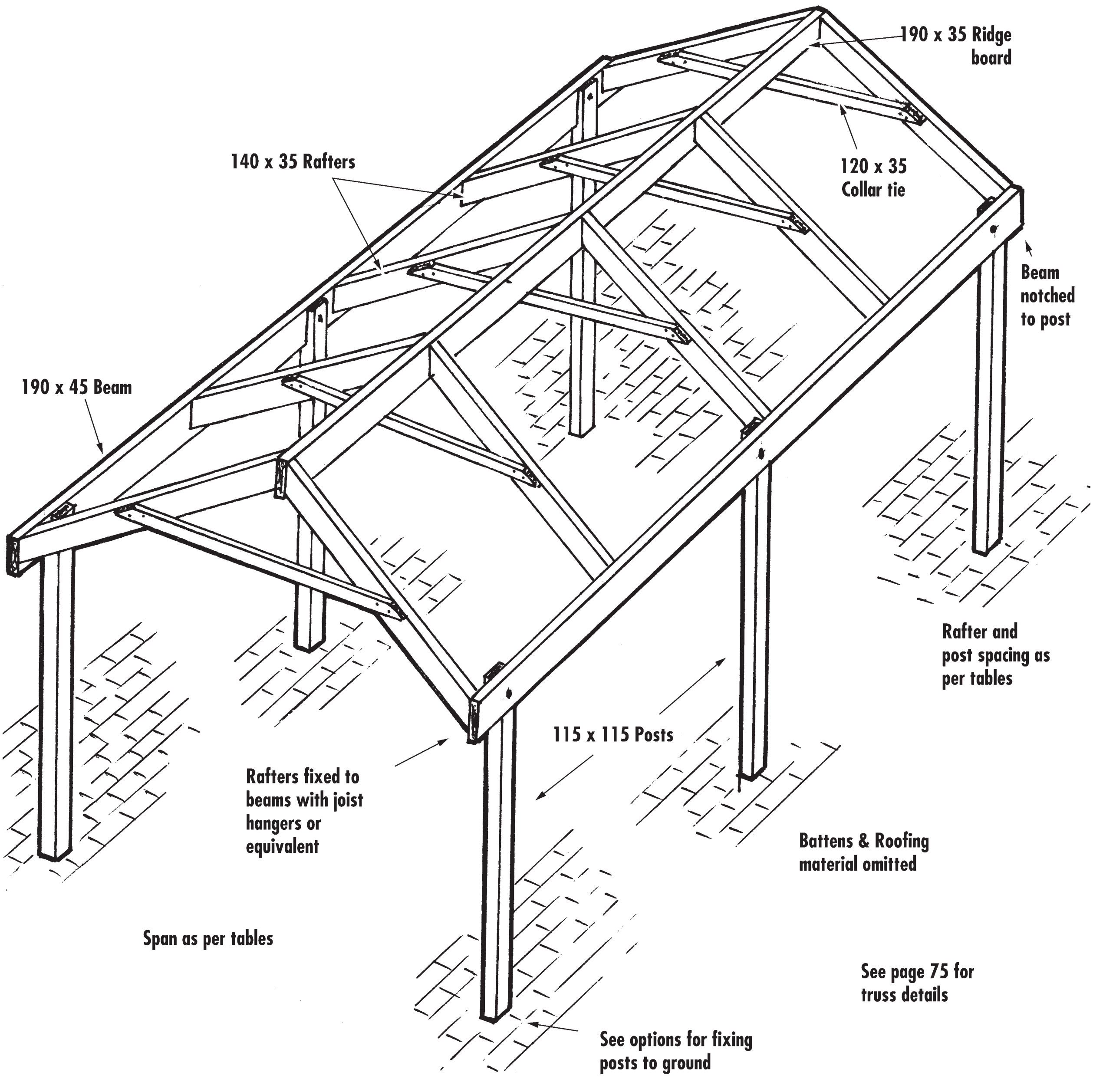


Figure 1.5
Freestanding gable roof frame.

Activity 4 Draw An Elevation

Draw the elevation of the outer wall of a timber house. Show framing details. The wall is to include a window and a door opening.

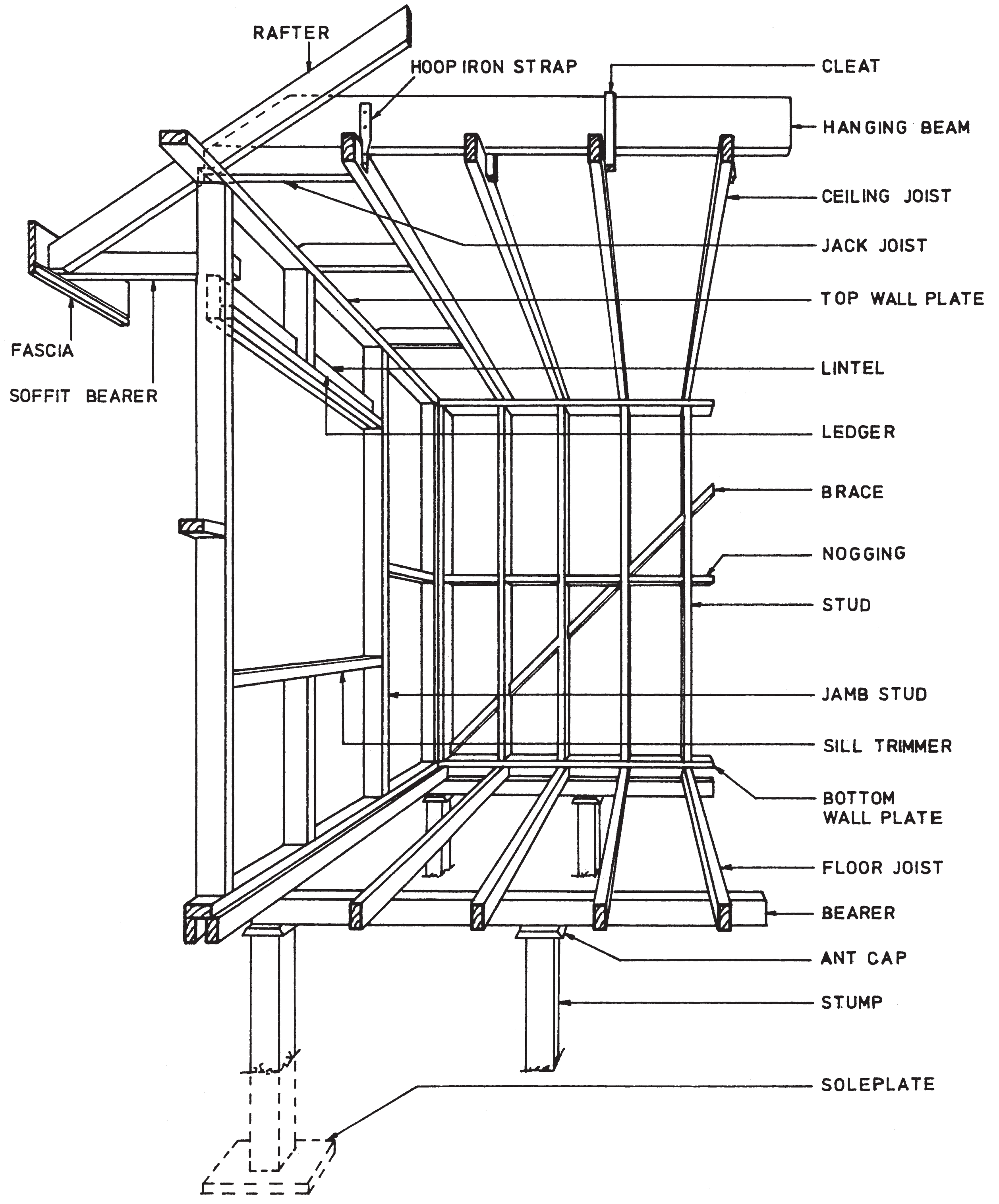


Figure 1.6
Wall framing.

Activity 5 Side Views

The illustration below shows an attached flat roof shelter. Prepare an architectural drawing of the left-hand view and the front view. Use the information given in the tables on pages 59 and 60.

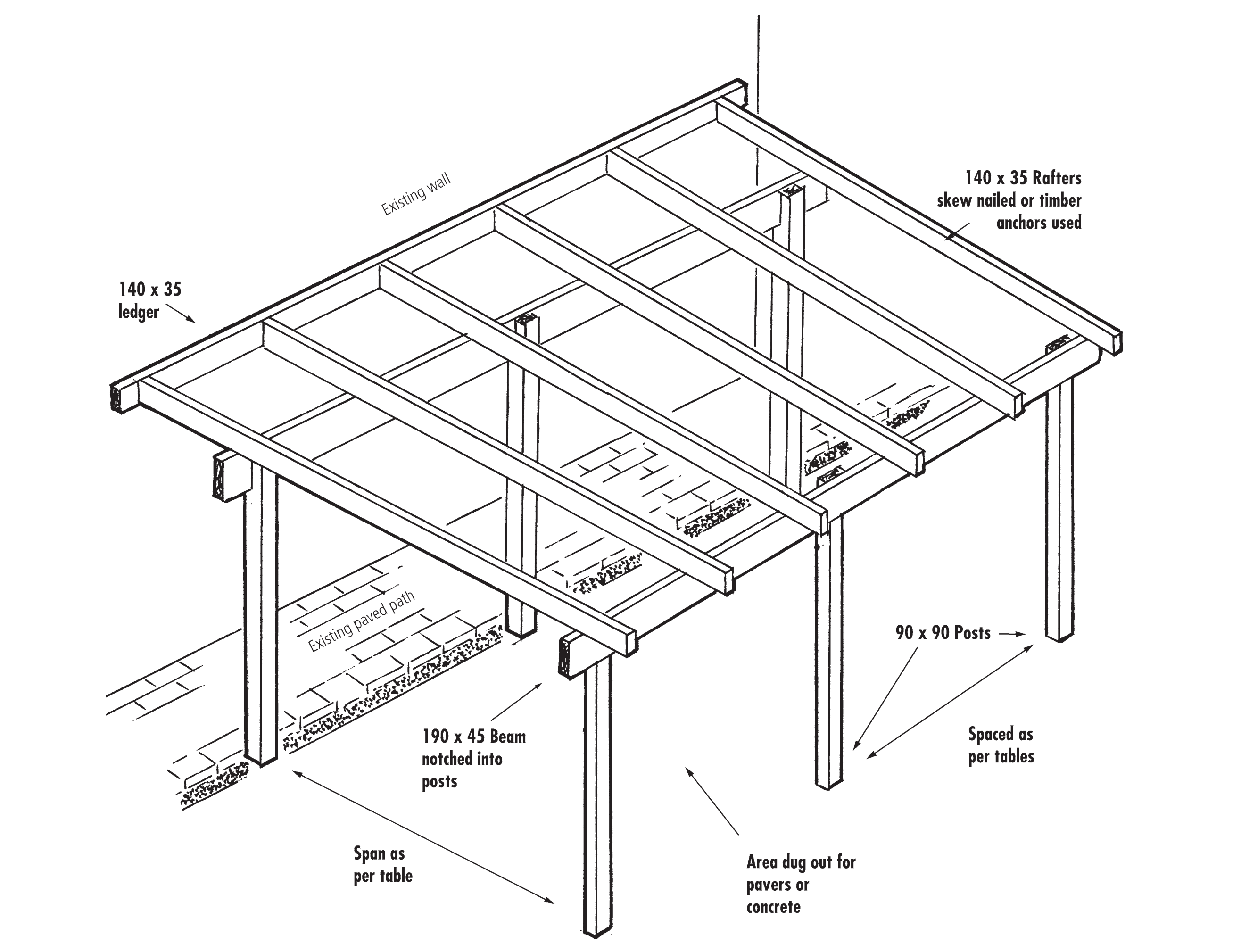


Figure 1.7
Attached flat roof shelter.

The overall dimensions of the shelter are:

Length: 7.2 m

Width: 5.0 m

Height: 2.4 m.

The drawing should include dimensioned details of:

- Post footings. (See Figure 6.6, page 55.)
- Beam and post attachment. (See Figures 7.5 and 7.6, page 63, and 7.7 on page 64.)
- Ledger attachment. (See Figure 7.8, page 64.)
- Method of securing rafters. (See Figure 7.13, page 69.)

Scale 1:50

Unit 2: HAND TOOLS

Objectives
At the end of this unit you should be able to:

- Safely use a number of 'gardening' tools for preparing building sites.
- Discuss and explain the function of hand tools which are used to construct buildings.
- Maintain and safely use a number of hand tools which are used to construct buildings.

Tools For Building Outdoor Structures

Site preparation tools
When you plan and build outdoor structures you need to use some tools which are commonly used for gardening or agricultural activities. For site preparation, digging post holes, filling post holes, and mixing concrete, etc., a number of 'gardening' tools are essential.

The following is a basic list of tools for use in site development:

Tools	Use
Pickaxe	For digging up rocks and soil.
Shovel	For removing soil, loading a wheelbarrow and mixing concrete.
Spade	For digging or enlarging post holes.
Mattock	For digging up compact soil.
Crowbar	For deepening post holes where soil is very hard, and tamping clean soil.
Rake	For levelling areas.
Wheelbarrow	For carting soil and concrete.
Post-hole digger	For digging post holes more easily.
Petrol/electric cement mixer	For mixing concrete more easily.

Hand Tools

The following sections describe some hand tools that are used in building, and preparing building sites.

String lines

String lines are used to mark out areas of a building site. For example, a string line is useful to show the position of a shelter, and to show where soil needs to be removed, or where post holes might be placed.

Modern string lines are available in plastic spring loaded containers (similar to tape rules). Some string lines have a 'chalk' coating. You fasten the string securely at both ends, pull the string up in the middle, and then let it go suddenly. The string hits the surface underneath and leaves a 'chalk' mark on the surface.

When you use string lines, it is important that they are securely attached to steel or wooden pegs. You must stretch the string tight to make sure it is accurate.

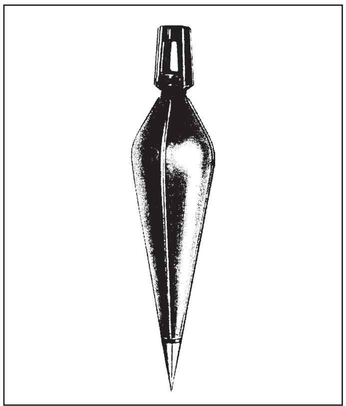


Figure 2.1
Plumb bob.

Plumb bobs

Plumb bobs are used to get a true vertical line. They are round pieces of brass or cast iron which have been accurately made so that they balance perfectly. You can attach them to a string line, and hang them from a nail. When the weight stops swinging, the string and weight will show a true vertical line.

You must be careful when you use a plumb bob that both the string line and the plumb bob are able to swing freely.

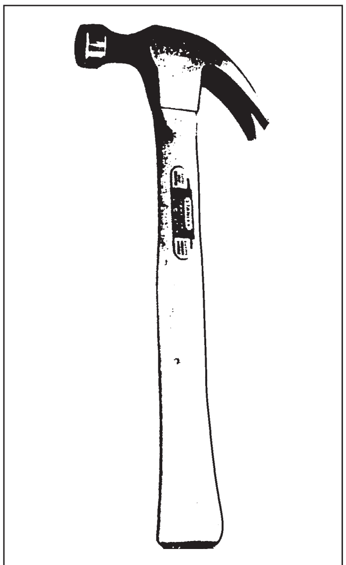


Figure 2.2
Claw hammer.

Claw hammers

The claw hammer is used to drive in or remove larger nails. When you choose a claw hammer, you should consider the following points:

- The hammer head should be made of forged steel. Forged steel does not shatter and the claws are unlikely to break.
- The claws should be split evenly. They should be bevelled (See design and Technology Year 10, page 33) so that you can remove the finest panel brads.
- If the handle is made of wood, the wood should be straight-grained hickory. The handle must be tightly wedged to the head, and correctly balanced.
- If the hammer has a steel handle, the steel must be covered with a cushioned hand grip, which will not slip.
- The striking face is the part of the hammer head which hits the nail. It should be slightly rounded.

Chisels

A chisel is a long-bladed hand tool with a bevelled cutting edge and plain handle which is hit with a hammer. Chisels are used to cut or shape wood, stone metal or other hard materials.

Spirit levels

Spirit levels are used to find true vertical and horizontal positions.

Spirit levels are made of timber, steel, aluminium, or plastic. They may have a varying number of vials. The vials are adjustable or non-adjustable, and may contain 'proved' or 'ground' glasses.

Proved glasses are made from glass tubing. They are slightly bent so that the high point is exactly in the middle. These are sufficiently accurate for carpenters.

Ground glasses, however, are more accurate. They are straight on the outside, and the inside is ground into a barrel shape.

For general-purpose use, the most satisfactory kind of level is:

- A one metre long aluminium level.
- With three or four adjustable vials.
- With proved glasses.

To test the accuracy of the spirit level, do the following:

- Place the level on a surface to see if the surface is level. If the surface is level the bubble in the vial will sit between the fine lines marked on the glass.
- Rotate the level through 180°.
- Check again for a level reading.

Figure 2.3
Spirit level.

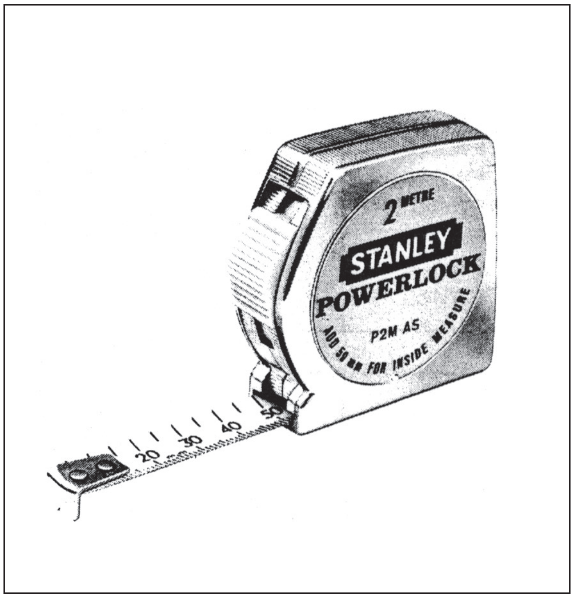


Figure 2.4
Tape rule.

Tape rules
To measure distances exceeding 300 mm it is often convenient to use tape rules.

Tape rules are made of flexible steel. They are spring loaded inside a steel or plastic case. Sizes range from 600 mm to 7 m in length. They are marked with mm, cm and m.

Because the blade is flexible, it can be bent to measure circles and curves.

To make it easier to read measurements many modern tapes have coloured blades. It is essential that the rivets, which attach the zero hook on the tape rule, are not fixed. This hook must be able to move when you measure inside dimensions, so that you do not include the measurement of the hook itself.

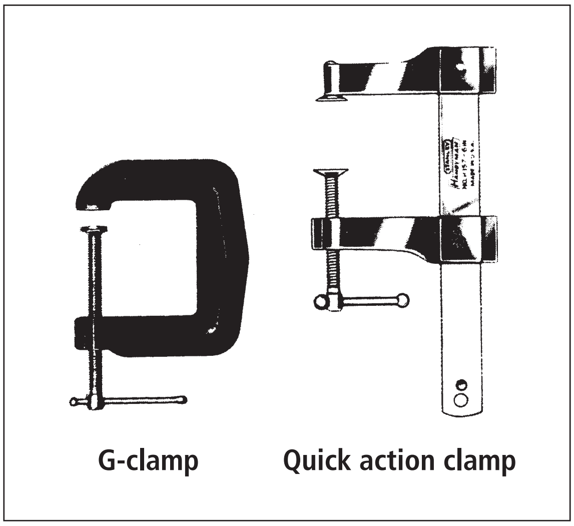


Figure 2.5
Clamps.

Clamps
Clamps are used to hold things in place so that they do not move.

Clamps are available in numerous types and sizes to suit many uses. The **G clamp** is often used to hold timber firmly to the bench so that you can saw, chisel or plane the timber.

The **quick action clamp** has the advantage of adjusting instantly to the size you need. It is self-locking with a plastic grip handle. It is a useful clamp for both carpenters and cabinetmakers.

Sizes range from 150 mm to 600 mm.

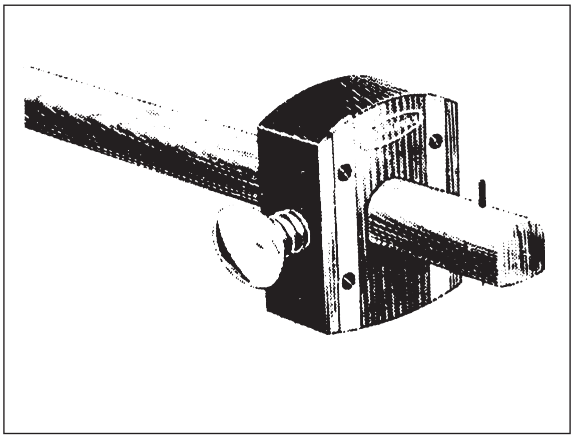


Figure 2.6
Marking gauge.

Gauges
The marking gauge is used for marking parallel distances along the surfaces of timber.

To set distances the adjustable stock moves along the stem of the gauge.

Lock the stock with the thumbscrew when you have the required measurement between the stock and the fixed spur.

Modern marking gauges have brass strips on the face side of the stock.

Method of Use
The marking gauge should be held in the 3–1 thumb grip. Press into the timber being marked to maintain a parallel line. Use similar pressure to push the gauge away from yourself.

On wide boards you may need to hold the material in the vice, and use both hands in order to maintain a mark parallel to the edge.

One end of the stem holds a fixed steel spur. It is often useful to drill a small hole at the other end to accommodate a pencil.

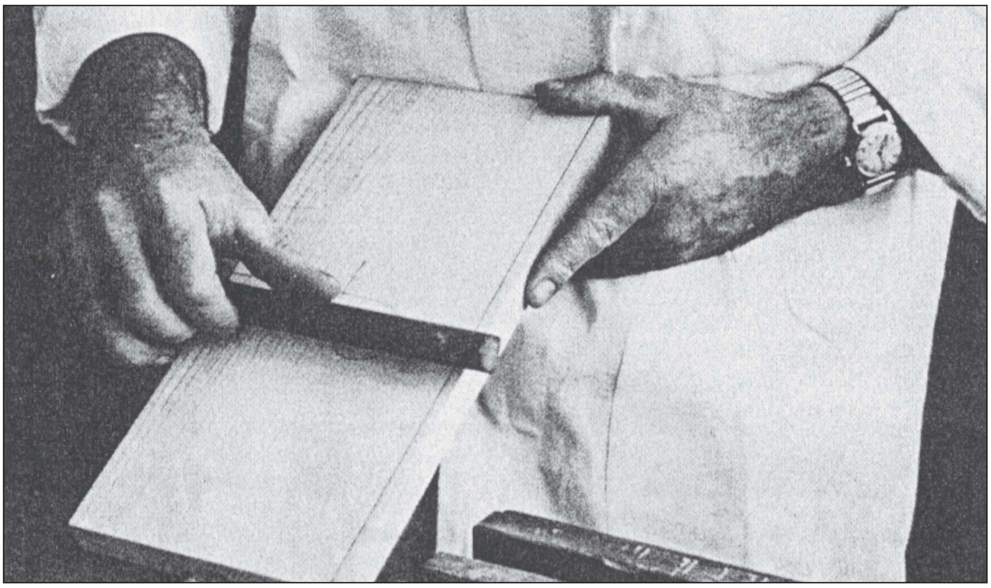


Figure 2.7
Gauging to width.

Crosscut saws
These are used for cutting across the grain of thicker timber. They may be used for ripping thin material. They are similar in appearance to rip saws, but they have slightly smaller teeth shaped like pointed knife edges.

The length of the blade varies from 500 mm to 700 mm, with 5 to 9 points per 25 mm.

Cutting with a crosscut saw
Hold the material firmly, and begin the saw cut gently, with the saw held at a low angle to the timber.

- When you have made a small cut (a kerf), raise the saw angle to 30°.
- Lengthen the saw stroke to use the whole length of the blade.
- To make a square and straight cut, the elbow, hand, and saw blade must travel in the same plane.
- When you have nearly finished the saw cut, reduce the forward pressure and the rate of sawing.
- Support the off-cut material.

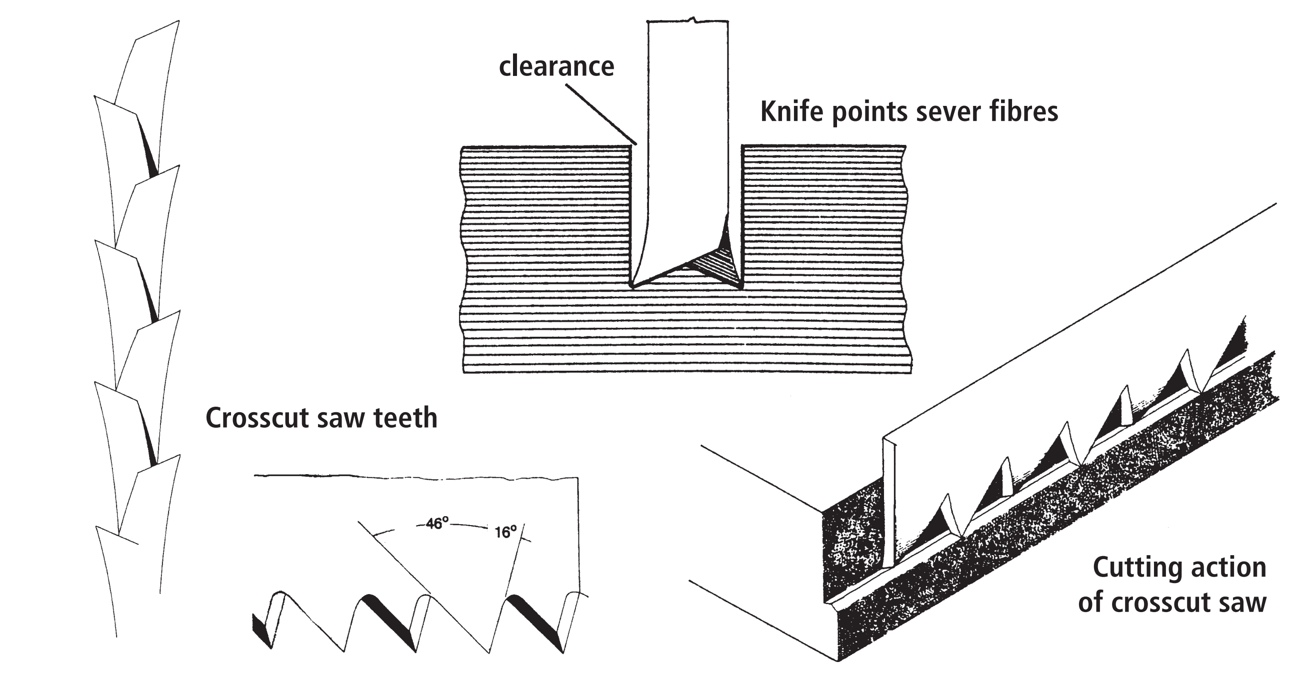


Figure 2.8
Cutting with a crosscut saw.

Panel saws

This saw is the most versatile handsaw. For general-purpose work, a panel saw 500 to 600 mm long with ten to 12 points per 25 mm is most satisfactory. Generally the panel saw is used for finer work both along the grain and across the grain. It is similar in appearance to the rip saw and the crosscut saw, but it is smaller, lighter and with teeth of the cross cut type.

Because panel saws have smaller and finer teeth than the ordinary crosscut saws, panel saws produce a clean and accurate saw cut in sheet material.

They are also useful for cutting the cheeks of large tenons. See Design and Technology Year 10, page 37.

Cutting with the panel saw

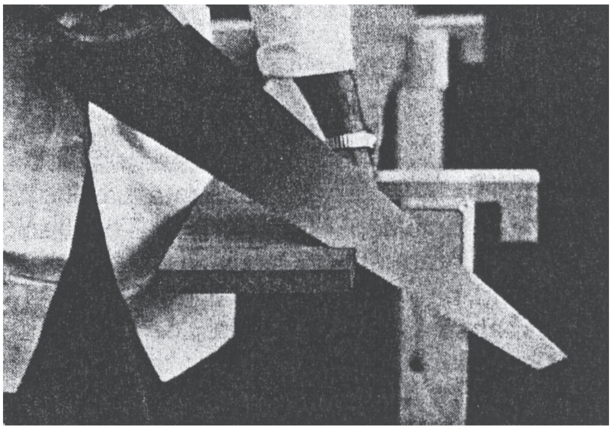
When you saw sheet material across the grain, you have to cut both the top and bottom surfaces with a knife before you start to saw. This is particularly important when you are cutting veneered manufactured boards because the veneer layer is extremely brittle, and breaks easily with rough edges.

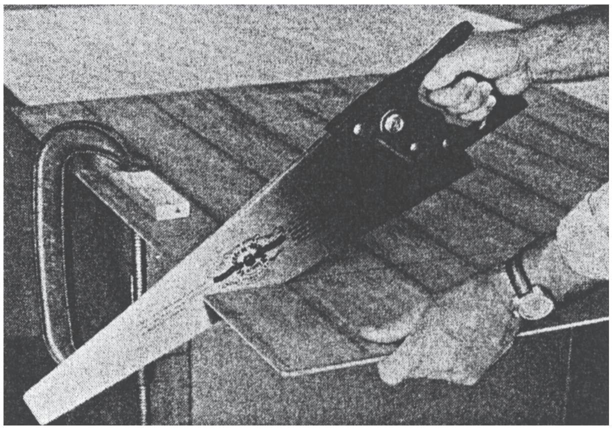
If you are cutting with the grain, a clear pencil line to saw along is sufficient.

Support the sheet on trestles, hold the panel saw at a low angle and gently pull the saw back just on the waste side of the line. The thumb of the supporting hand should be used as a guide while the first small cut (the kerf) is being made.

Use the full length of the blade, applying slight pressure only on the forward stroke.

Both the crosscut and panel saws are appropriate for jointing and cutting timbers to size when constructing basic shelters or decks.





Using hand saw to cut across the grain

Panel saw cutting plywood panels

Figure 2.9
Cutting with a panel saw.

Sliding bevels

This square, also known as an adjustable bevel, has a sliding blade which is adjustable to any angle with the stock. It is used for setting out and testing bevels and splays, or where the joint line is other than 90° or 45°.

Bevelled edges are planed off to an angle that is not a right angle.

A splayed side is planed to an angle that is not 45° to the edge.

It is most useful for laying out the angles when cutting the rafters for a gable roof.

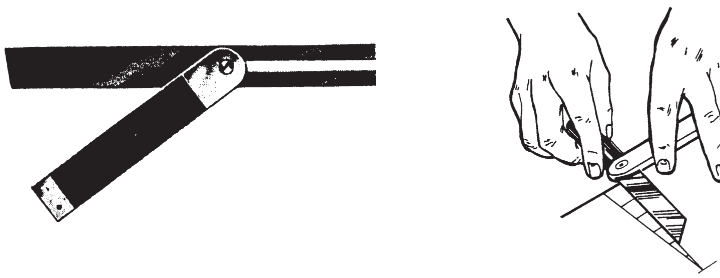


Figure 2.10
Sliding bevels.

Tamping tools

When you are laying pavers it is essential that the soil fill, either 'dolomite' and/or sand, is packed down to give a firm and reasonably level surface.

Contractors who are laying large areas of pavers would have access to a petrol-driven tamping machine. However, for smaller areas, a hand tamping tool is quite sufficient.

A hand tamping tool consists of a short length of 20 mm water pipe with a handle at one end and a piece of flat steel 200 mm × 180 mm at the other. A piece of hardwood is attached to the flat steel to give a broader base.

By using an up and down motion the tamper will flatten and compact the soil.

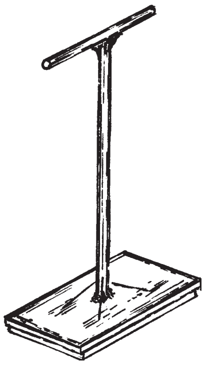


Figure 2.11
Tamping tool.

Unit 3: PORTABLE POWER TOOLS

Objectives

At the end of this unit you should be able to:

- Understand the need for and function of specialised power tools (including cordless power tools) used in building outdoor structures.
- Maintain these tools in a safe working condition.
- Use these tools safely and appropriately.

General Safety Precautions

Safe procedures	
Keep your work area clean.	Cluttered areas and benches result in injuries.
Consider the work area environment.	Don't use power tools in wet locations. Keep your work area well lit.
Use the right tool.	Don't use tools for purposes they are not designed for.
Dress properly.	Don't wear loose clothing or jewellery. Wear protective hair covering for long hair.
Use safety glasses.	Also use face or dust mask if your cutting operation is dusty.
Secure your work.	Use clamps or a vice to hold the work.
Don't overreach.	Keep firm footing and good balance at all times.
Maintain the tools.	Keep your tools sharp and clean.
Use outdoor extension cords.	Use only extension cords intended for outside use.
Avoid unintentional starting.	Be sure the switches are OFF when plugging in power tools.

Portable Circular Saws

Portable circular saws are designed for use away from the workshop. These machines are widely used by carpenters on the job for framing, roofing, and flooring. Portable circular saws are available in a variety of sizes. A range of blades is available for cutting a variety of materials.

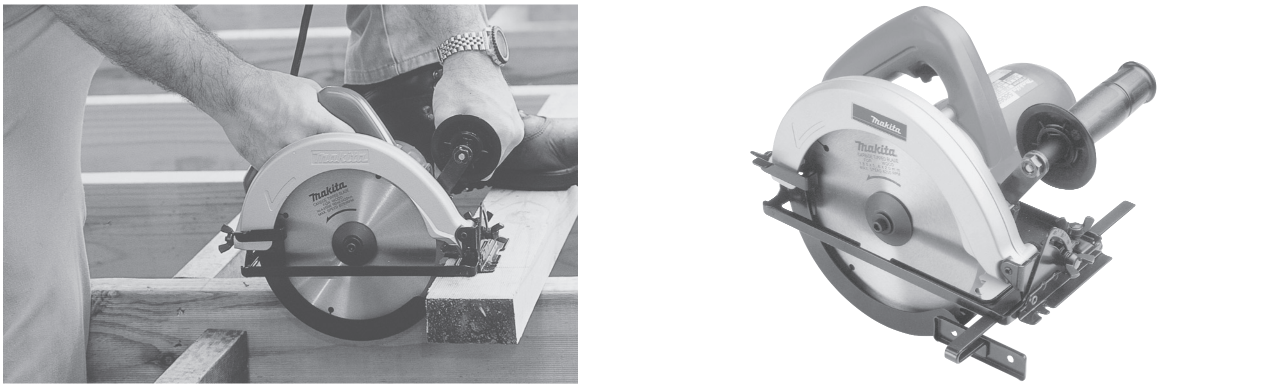


Figure 3.1
Circular saw.

Specifications

Portable circular saws are designed to cut effectively at all angles between 90° and 45°. When a portable saw is fitted with a rip or crosscut saw blade, the saw will cut a variety of profiles, including rebates, chamfers, and grooves, in either hardwood or softwood. (These terms are discussed in Design and Technology Year 10, pages 33 and 34.)

A portable circular saw is described by the size of the largest blade that will fit into it. This will vary from about 180 mm to 240 mm. For example, a 200 mm portable circular saw can be fitted with a blade with a maximum diameter of 200 mm.

Operating adjustments

Most portable circular saws are fitted with a fence to guide the saw while ripping a board. This fence is easily adjusted. It is essential to make sure that the locking device is firmly clamped before operating the saw.

The depth of the cut is adjusted by moving the base so that the blade protrudes the same amount as the depth of the cut you want to make.

Bevel cuts are also possible by tilting the machine on its base so that the blade is at the angle that you want.

Portable saws are also equipped with spring loaded guards for the blade. These guards must be maintained in good order so that they operate correctly.

Using a portable saw

1. Place the base of the machine on the timber with the blade just clear of the timber.
2. Switch on the saw.
3. Allow the blade to come to full speed before beginning to cut.
4. Begin the cut by pushing the saw into the timber. As the blade enters the cut the spring loaded guard is pushed back by the timber. When the cut is complete, the guard returns to the safe position.

5. When the cut is finished, release the switch
6. Hold the saw in the finished position until the blade is stationary.

The safest method is to use a fence to guide the machine, but the saw may be used freehand. If you use a saw freehand, it is essential to align the work carefully, and feed the saw through the cut carefully, following the line.

Extra care must be taken if you use a saw freehand.

Safety

- You must wear eye and ear protection.
- The timber must be well supported, either with sawhorses, or clamped to a bench.
- Make sure all adjustments are made before you connect the saw to the electric power.
- Always stand clear of the line of cut.
- Always use both hands to guide the machine through the cut.
- Always disconnect the saw from the power when you make adjustments.
- Never use a blunt saw blade or one that has no set.

Portable Planers

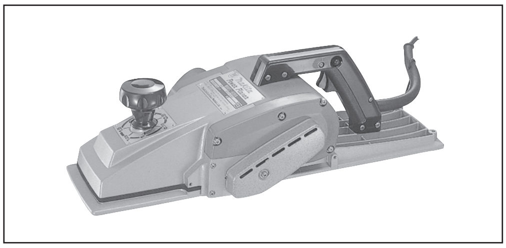


Figure 3.2
Portable planer.

Portable planers are designed for use either in the workshop or out on a job. They are available in many blade widths. They are generally supplied with a carry case and a number of accessories.

These machines are widely used by carpenters, boat builders, and cabinetmakers.

Specifications
Generally the size of the blade width varies from 80 mm to 170 mm. Most portable planers have a maximum depth of cut around 3 mm. Portable planers are relatively heavy varying between 2.5 kg to 8 kg.

Operating adjustments
Most portable planers are fitted with a fence for planing rebates of varying widths and depths.

Guides can also be adjusted or removed for planing bevels, splays, and chamfers. The depth of cut can easily be adjusted by turning a knob which controls a mechanism linked to the cutting block.

Using the portable planer
To start the machine pull the trigger. Release the trigger to stop.

Wait until the planer is running at top speed before you bring it into contact with the timber. Planing will be easier if the timber is held level, either in a vice or clamped firmly to a bench. Never plane up a sloping piece of timber.

Starting and finishing work
Rest the front of the planer flat on the work surface, switch on and move the planer gently forward. At the end of each stroke, apply pressure to the back of the planer. Lift the front of the planer as the cutters pass over the end of the timber. For a fine finish, the planer should be moved more slowly over the work.

Safety

- You must wear eye and ear protection.
- The timber must be well supported, either with sawhorses, or clamped to a bench.
- Make sure all adjustments are made before you connect the planer to the electric power.
- Make sure that the timber is sound and there are no loose knots or nails.
- Check the grain direction and match the direction of planing to the grain for a smooth finish.
- Always disconnect the planer from the power when you make adjustments.
- Never use a planer with blunt blades.
- Make sure the planer has come to a dead stop before you place it on a bench.
- Do not wear loose clothing.

Portable Drills

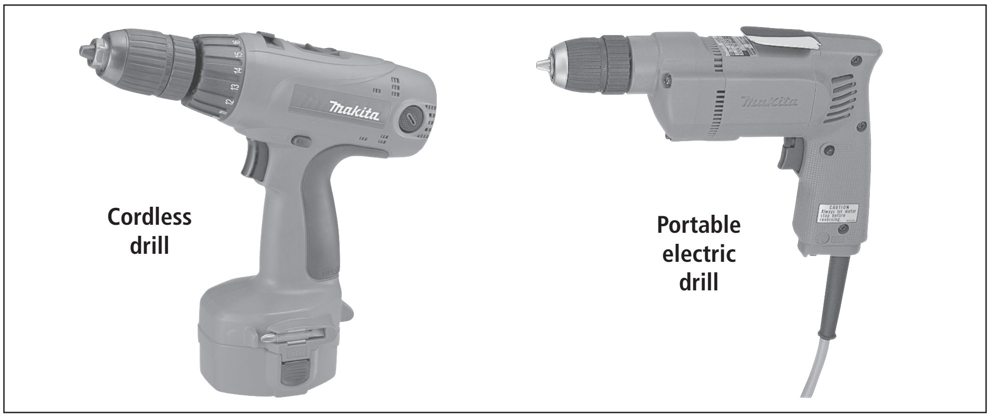


Figure 3.3
Portable drills.

Portable electric drills are available in a wide range of sizes and types. Carpenters and builders use portable drills, but they are also commonly used by people in their homes. There is available a very large range of accessories which increases the types of work that may be done with a drill.

Specifications

Modern electric drills are usually:

- Double insulated.
- Have a variable speed or an electronic speed feature.
- Are reversible.
- They may have a keyless chuck. (The common chuck sizes available are 6.5 mm, 10 mm and 13 mm.)
- Some drills may be classified heavy duty and have one or two speeds.

Cordless drills (battery operated) have become increasingly popular with the handyperson and the trade-person because they are easy to use in many construction tasks, or where electric power is not accessible. There is a large range of cordless drills now available. Standard features generally include variable speed, torque settings, two speed gearboxes, keyless chuck and often a one hour fast charge battery.

Whether you choose to use an electric drill or a cordless drill depends on many factors. If you plan to use accessories, or plan heavy duty use, a 10 mm two speed drill is desirable.

There are also drills which are designed to drill concrete and masonry surfaces. These drills are known as hammer drills. They are used widely by tradespeople.

Using the portable drill

For straightforward drilling jobs, make sure the drill bit is inserted to the full depth and the chuck key is removed before starting. Holes larger than 13 mm should be drilled using the slow speed. Holes in steel or concrete require a slower speed than equivalent holes in wood.

Hold the drill perfectly straight or level to prevent bending or breaking the drill bit. Centre punch the position of the hole so that you can position the drill accurately, especially in metal, concrete or masonry.

Drilling to depth

- You can fit a depth stop to the drill which will stop your drilling at the depth you choose.
- You must ‘back out’ the drill continually to clear the shavings.
- Do not drill right through a piece of wood, because you are likely to split the other side of the wood, where the drill exits. You may prevent the wood splitting at the back if you clamp a scrap of wood to the back of your timber, and drill into the scrap.

Drills and bits

- *Twist drill bits*: When the holes to be drilled are not very large or deep, use a twist drill bit. These bits have a straight shank but are shaped with open flutes which clear the shavings out well. This makes drilling easier. When you regrind these bits, the 60° angle of the point should be maintained. Sizes range from 3 mm to 15.8 mm diameter.
- *Spade bits*: Spade bits cut smooth, clean holes. They have a brad point which allows you to drill at an angle. These bits are suitable for use in drill presses and portable electric drills. Sizes range from 6 mm to 25 mm diameter in increments of 1.5 mm.
- *Forstner bits*: Forstner Bits can drill any arc of a circle. Their direction is not changed by knots or difficult grain in the wood. Unlike other bits, Forstner bits are guided by their circular rim and not by their centre point. The holes which these bits drill are clean, true and flat-bottomed. Sizes range from 9.5 mm to 75 mm diameter with 1.5 mm increments.
- *Masonry drill bits*: These drill bits have tungsten carbide tips. They are designed to drill through bricks, stone, marble, concrete, and other masonry materials.
- *Machine countersink bits*: These bits are used to enlarge the rim of a hole so that the head of a screw, nail or bolt can be inserted flush with the surface.
- *Hole saws*: These are suitable for drilling wood, hardboard, sheet metal, and fibreglass. They are designed for use in a power drill. The adjustable twist bit is replaceable.

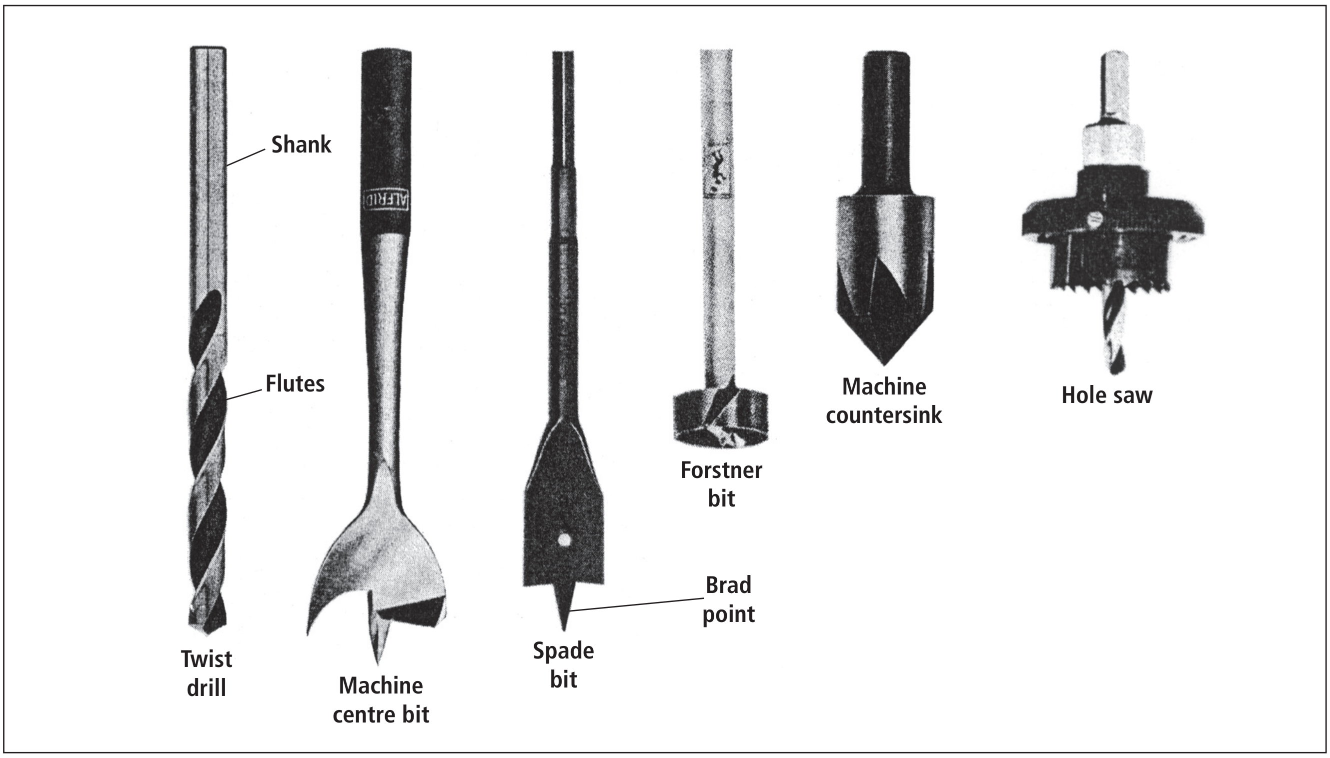


Figure 3.4
Drill bits and hole saws.

Safety

- You must wear eye and ear protection.
- Do not wear loose clothing.
- Check the drill size-speed relationship.
- Clamp your work securely to prevent spin off.
- Use only recommended drill bits.
- Press just hard enough to produce shavings.

Portable Jigsaws

Figure 3.5
Portable jigsaw.

Portable jigsaws are used by craftspeople in many fields. They are used for light work such as cutting thin sheet materials, plywood, sheet steel, and plastics.

Specifications
Modern portable jigsaws are double insulated. They are easy and comfortable to use. Good quality machines have a tilting base for cutting angles, and often have a variable speed control from 0 to 3200 strokes per minute. On some jigsaws you can adjust the blade movement for different types of materials.

Operating adjustments
Jigsaws are designed so that you can adjust them easily. Carefully read the manufacturer's specifications for each jigsaw so that you understand completely how to use it. The method of inserting the blade is different with different makes and types of jigsaw. When you are cutting tight curves you have to fit narrow blades. When you are cutting metal or plastics you may need to use a lubricant to prevent overheating. You must consider the length, pitch, and set of teeth so that the blade cuts the material effectively, depending on whether it is wood, metal, or plastic.

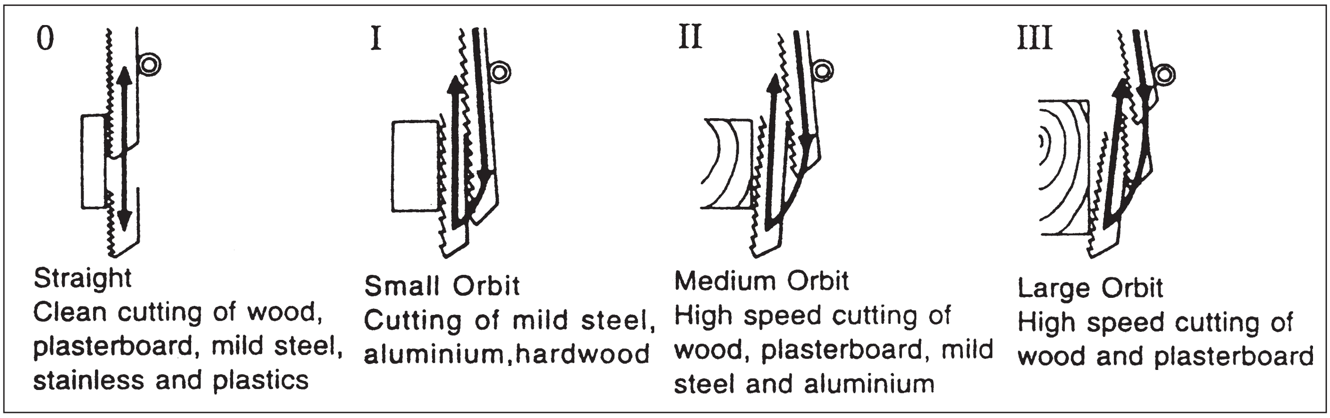


Figure 3.6
Orbital blade action.

Using portable jigsaws

Figure 3.7
Using portable jigsaws.

The jigsaw is used to make curved or straight cuts. The cuts may also be bevelled by tilting the base.

Hold the base firmly on the surface you are going to cut. Move the jigsaw at a rate depending upon the thickness and type of material.

The blade cuts on the up stroke. Splintering is likely to occur in thin wood materials, particularly plywood. Take this into account when you make finishing cuts. You can easily start cuts from the edge of the material For internal cuts, you may need to drill a starting hole. Most jigsaws, however, are capable of direct piercing or plunge cutting to make an internal cut.

Safety

- You must wear eye and ear protection.
- Do not wear loose clothing.
- Make sure the jigsaw is turned OFF before you connect it to the power.
- Disconnect the jigsaw before you change blades and make adjustments.
- Select the correct blade for the material you are going to cut.
- Do not bend or twist the blade while you are cutting curves.

Cordless Tools
Recent innovations have produced a new generation of direct current (DC) cordless motors. These longer life motors also have better battery capacity and reduced battery charging time. As a result of these new developments, there is a bigger range of good quality cordless tools on the market now.

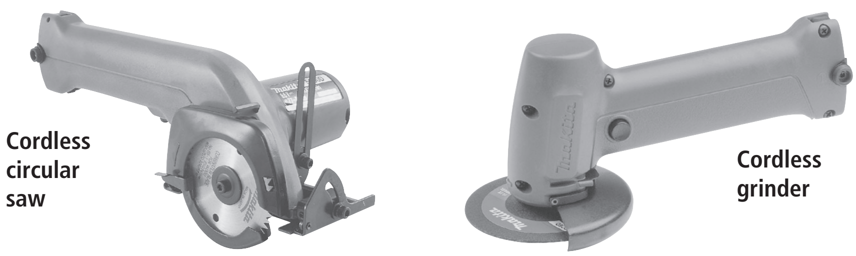


Figure 3.8
Cordless tools.

Unit 4: MATERIALS

Objectives

At the end of this unit you should be able to:

- Understand, discuss and identify the manufacture, types and uses of plywood.
- Understand, discuss and identify the production and uses of medium density fibre board.
- Understand, discuss and identify the production, types and uses of particle board.
- Understand, discuss and identify the manufacture, types and uses of hardboard.

Plywood

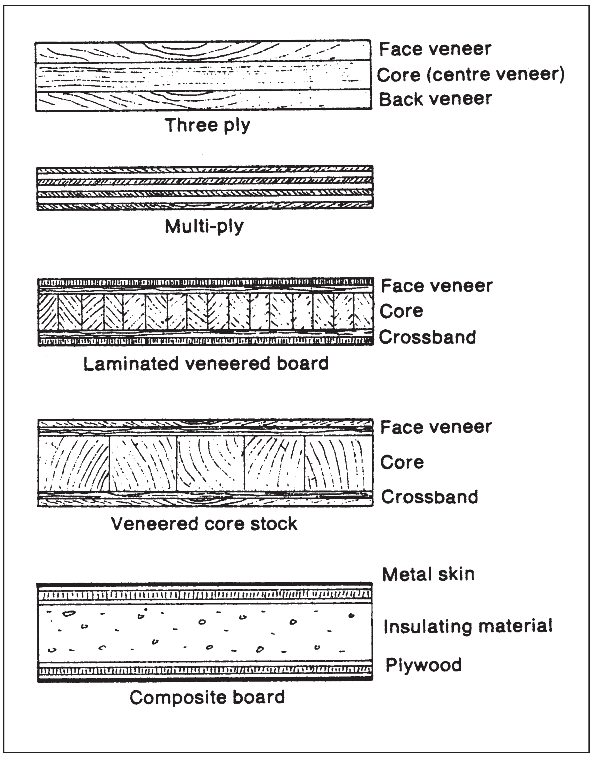


Figure 4.1
Types of plywood.

Plywood is an engineered panel made up of thin layers of wood glued together. These layers, called plys or veneers, are arranged so that the grain direction of each layer is at right angles to the grain direction of the layer next to it.

The outside plys are called face veneers and back veneers. The centre ply, or plies, are the core. The veneers immediately below the face veneer and the back veneer are known as crossbands.

The simplest plywood is made up of three layers of veneer. There is always an odd number of layers. Five, seven, nine or more layers may be used.

The strength of timber is much higher along the grain, than across the grain. Its shrinkage is greatly lower along the grain. Plywood produces a stable board that is strong in all directions. This is because it has high strength and low shrinkage in both directions, with the length of the grain going in different directions in alternate layers.

Plywood has been used for a long time for furniture construction, but it was not used as a building material until the mid-1930s. At that time the development of synthetic resins for glues made its potential as a building material clear.

Plywood production

The production of plywood begins in the lay-up section. It is there that the graded or matched veneer faces and longbands are assembled with the crossbands in preparation for glue spreading.

Matching means that several face veneers are clipped to size and matched to give the appropriate appearance.

The veneer edges must be made square and straight so they may be butt jointed and taped or spliced with the least possible visible joint line.

Taping

The matched veneers are taped together with gummed paper to form a full veneer sheet. The tape must be removed later, by sanding.

Tapeless splicing

In this method, a tapeless splicer seals the glued edges by electrically curing the glue. This method has the advantage of having no tape.

Common methods of matching face veneers include:

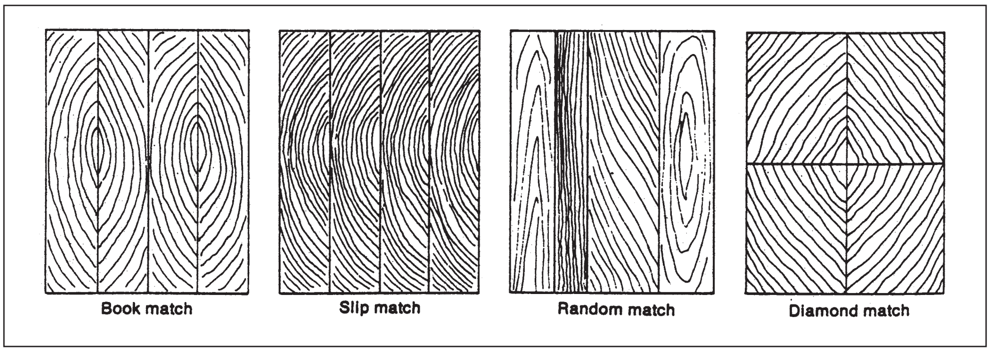


Figure 4.2
Veneer matches.

Book match	Sheets of veneer are alternately folded out like the leaves of a book. All types of veneers may be used.
Slip match	The veneer sheets are laid side by side to provide a consecutive repeated figure. All types of veneers may be used.
Random match	The veneers are joined to create a deliberate mis-match. Veneers from various flitches may be used.
Diamond match	This form of matching is generally given to stump, butt or crotch veneers. Diamond matching highlights the beauty of grain formations.

Gluing

The glue spreading operation coats the crossbands on both sides simultaneously. The thickness of the glue is automatically controlled by the gap between the spreader roll and the doctor roll.

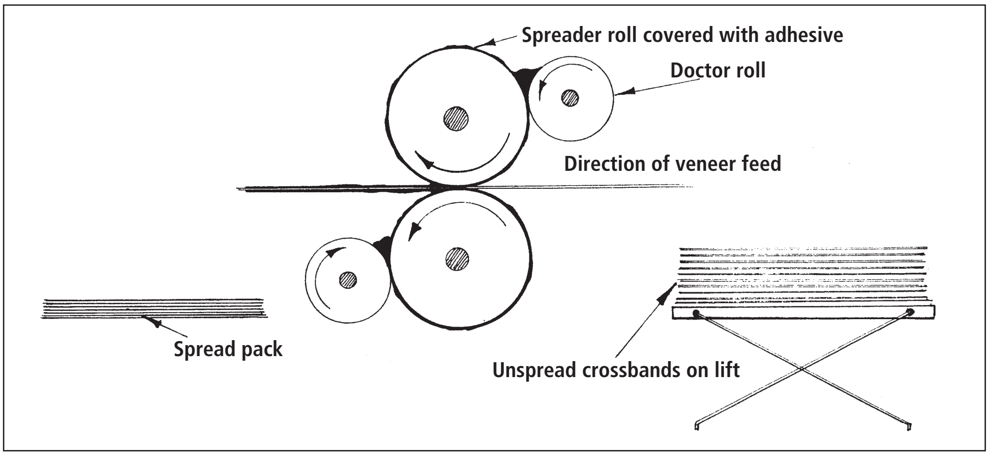


Figure 4.3
Glue spreading.

The glued crossbands are arranged with the appropriate number of longbands to form packs of glued veneers ready for the first pressing operation.

Pressing

Pressing the plywood sandwich makes sure that the veneers and glue are in close contact. This can be done by a cold pressing or a hot pressing process.

Pre-pressing is performed in a cold press which has one large daylight (or opening). The cold press can hold two or three hot press loads at a time.

This operation moves the glue from the spread to the unspread surfaces of the veneer. This produces a more even glue bond.

In the hot press, the spread sheets of ply are bonded together under high temperature and pressure. The press platens (top and bottom flat plates of the press) may be heated with steam, hot water or oil. The spread pack of plywood remains under pressure and heat until the glue has cured.

After curing, the plywood is trimmed and sanded to complete the production process. The sheets are passed through trim saws to trim them to accurate length and width dimensions.

To sand the sheets, they are passed through a drum sander, where both surfaces are sanded to an even thickness.

The last stage in production is the inspection and grading process. Sheets which need repair are removed from the production line. Checks, splits and dead knots are removed from the sheets. Sound pieces of veneer are inserted in the holes by a special machine.

Plywood glues (adhesives) are derived from synthetic resins and are all thermosetting. This means they need heat to set.

The following tests show differences in adhesive quality. The adhesive quality of a bond goes from Type A to Type D in descending order of permanence. That means Type A bond is the most permanent, and Type D bond is the least permanent. Different glues (adhesives) have different bond quality, and are used for different purposes. If the plywood is going to be used for a purpose where it does not need to last very long, then the most permanent adhesive (Type A) is not needed.

- Type A bond has a glueline that will not deteriorate if it is immersed in water, or if it experiences extremes of heat and cold. It is easily recognised by the black colour of the glueline. It is used for marine, exterior, and structural plywood.
- Type B bond will break down if it is immersed in water. The glueline, therefore, is classified as not fully permanent. It is ideal for use as concrete formwork, because it has a limited life expectancy.
- Type C and D bonds are manufactured for interior use only. They should not be used in structural applications where there may be long term stresses.

Classification Of Plywoods

Plywood products are in two broad categories: construction ply and decorative ply.

Construction plywoods

Marine plywood, exterior plywood, structural plywood, and overlaid plywood, are all types of construction plywoods.

Marine plywood is produced from timber species which are suitable for marine situations. The timber properties are necessary for marine situations include:

- Low water absorption.
- High strength to weight ratio.
- Durability.

Marine plywood is suitable for use where high strength and durability are required, or where medium strength but extreme lightness is necessary, for example, in racing class boats.

Exterior plywoods are available in Type A bond which is suitable for permanent exposure; or in Type B bond, which is suitable for similar exposure conditions but for a limited period. The face veneers of exterior plywoods are free from defects. They are suitable for painting or staining.

Structural plywoods may be made of *Pinus* species or hardwoods. Structural plywoods are standardised, low cost, engineered sheets. They have many uses in building, industrial and agricultural projects.

Overlaid plywoods are construction plywoods that have another material overlaid on top of the timber surface. These overlay materials give better resistance to weather conditions and abrasion when that is needed. The overlays may include plasticised film, aluminium, stainless or galvanised steel, or fibreglass.

Decorative plywoods

Rotary interior plywood and sliced decorative plywood are both types of decorative plywood.

Rotary interior plywood has a face veneer which consists of one or more veneers of matching colour. These veneers are edge jointed to make up the face veneer. Rotary interior plywood is used extensively in the building and furniture industries.

Sliced decorative plywood has the advantage of allowing the grain pattern to be highlighted by matching techniques. In the case of some species of timber, sliced veneer shows the natural figure in a way that rotary peeling is not able to do. Sliced decorative plywood is more expensive than rotary interior plywood.

Summary of Standard Types and Thicknesses

Use	Bond	Face Veneer	Length (mm)	Width (mm)	Thickness (mm)
Marine	A	Selected rotary Sliced	900 1200	1800 2400	3–25
Larger hardwood (structural)	A	Rotary hardwood veneers	900 1200	1800 2100 2400	7–17
Pinus (structural)	A	2.5 mm Pinus veneers	900 1200	1800 2100 2400 2700	7–22
Exterior	A or B	Most rotary and sliced species	900 1200	1800 2100 2400	3–25
Overlaid	A or B	Overlaid rotary species	900 1200	1800 2100 2400	2–19
Sliced faced plywood	D	All sliced species	900 1200	1800 2100 2400	3–20
Random grooved plywood	D	Selected rotary and sliced species	900	2100 2400 2700	4–6
Commercial plywood	C and D	All rotary species	900 1200	1800 2400	25
General purpose blockboard	C and D	All sliced and rotary species	900 1200	2700 1800 2100 2400	20

Medium Density Fibre Board

Medium density fibre board (MDF) is a reconstituted wood product. It has a smooth, high-density surface with excellent machining properties. It is suitable for painting and staining. Plantation-grown radiata pine is the main species used in the manufacture of MDF.

Manufacture

Step 1 First, remove the bark from the log. This is generally done by using a ring de-barker to:

- Remove the majority of bark.
- Assist in removing grit.
- Give a higher quality surface finish to the final product.

Step 2 The logs pass through a chipper to reduce them to a specified chip size. It is possible to blend chips from different timber species where certain properties are required. For example, eucalypt chips may be used to improve moisture resistant qualities in the finished board.

Step 3 The chips are washed.

Step 4 The washed chips are passed through a defibrator, which uses high pressure and high temperature to separate the fibres of the wood chips. The result is a light and fluffy pulp.

Step 5 The fibres are mixed with paraffin wax and thermosetting synthetic resins. The paraffin wax helps to make the board water repellent. The synthetic resins help to bind the fibres together and give the MDF board stability. Other chemicals, such as insecticides, fungicides and fire-retardants, can also be added to provide specific protection.

Step 6 The fibres are spread uniformly onto a conveyer belt to form a mat. The mat may be cut to size ready for pressing. Otherwise, the mat passes through a continuous press where the boards are cut to required lengths.

The production of continuous board has two main advantages:

- It allows greater flexibility in meeting demand for different sizes of board.
- It reduces waste.

Step 7 The boards are left to cure for up to seven days, depending on their thickness, density and resin type.

Step 8 The boards are then fine sanded on wide belt sanders.

Working properties of MDF

- It has homogeneous structure in all directions.
- It can be edge machined, similar to wood.
- It is easily moulded and routered.
- It has a fine smooth surface which accepts various finishes.
- It has excellent dimensional stability.
- It has good tonal qualities, and is suitable for finishing, for example, speaker boxes.
- It is easily worked by hand.

Screws should only be inserted into the face of MDF boards. Experience has shown that if you put screws or nails into the edges of MDF, the fibres separate. This separation of the fibres reduces the strength of the board and can cause it to split.

Uses

MDF is extensively used by builders and furniture manufacturers because:

- It has uniform thickness.
- It has dimensional stability.
- It has good working qualities.
- It is availabile in a range of sizes. The large sizes are particularly useful.

Particle Board

Particle board is a sheet material manufactured from small pieces of wood, or other ligno-cellulose materials. The wood pieces are bound together by a synthetic resin (binder) using heat and pressure.

Particle board was first produced experimentally in Switzerland during the late 1930s by mixing thermo-setting adhesives with wood particles and pressing under heat to produce a flat homogeneous board.

Raw Materials

Two materials only are required — wood particles and a synthetic resin adhesive. Wood particles or flakes make up 90 per cent of the weight of particle board. The wood species used are generally pine, such as *Pinus radiata*. The pine comes from forest thinnings and sawmill residue (slabs, offcuts, dockings).

Synthetic resins are used because their formulation can be varied and they have the advantage of a flexible curing time. There are currently three types of resin in use:

- Urea-formaldehyde (interior particle boards).
- Melamine-formaldehyde (particle board flooring).
- Phenol-formaldehyde (high moisture resistant particle board).

Optional additives may include paraffin wax for repelling water and dimensional stability, insecticides and fungicides, and fire-proofing chemicals.

Manufacture

Step 1 The wood flakes are produced either by flaking and cutting, or by impact and breaking, depending on the source of the raw material:

- Forest thinnings, slab wood and peeler cores are usually reduced by cutter type machines. This produces flakes of controlled length and thickness.

- Sawmill residues such as slabs are usually chipped, flaked or broken up by hammering in special machines.

Step 2 The wood particles then pass through driers. The driers reduce the moisture content of the wood particles to between three and five per cent.

Step 3 The particles then pass through screens and wind-sifters:

- To remove heavy or thick particles.
- To remove excessive dust.
- To grade particles into sizes.

Step 4 The addition of glue to the particles is known as blending. Resin, in the form of a liquid, is forced through nozzles and sprayed onto the particles. Other optional additives are included in a similar manner.

Step 5 The glued wood particles are placed in spreaders, which spread the particles onto mats. The mats are built up to the required weight in one of two ways:

- By several passes under a single spreader.
- By one pass under several spreaders.

Step 6 The mats are then carried to the hot press on a mat transfer belt (or caul).

Types of Mats

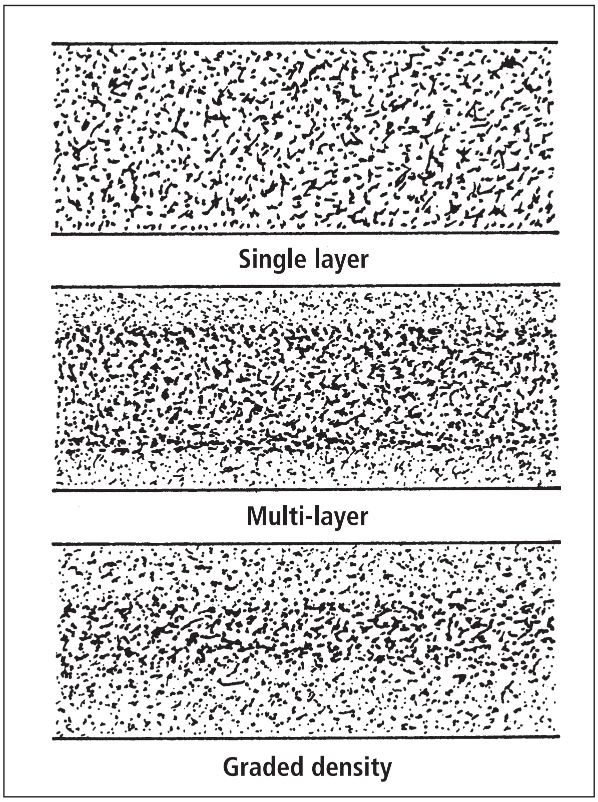


Figure 4.4
Types of particle board.

Single layer: The single layer particle board mat is one layer of the same particles. Fine and coarse particles are evenly distributed throughout the thickness of the mat.

Three-layer: In a three-layer mat the two outside layers of particles are fine. These outside layers of fine particles contain more glue and moisture than the layer of coarser particles in the centre (the core). After the mats have been pressed, the surfaces of the boards are of higher density than the core. The three-layer (or sandwich construction) mat is the most commonly used in the furniture industry.

Multi-layer: The multi-layer mat is similar to the three-layer mat, except it has a larger number of layers.

Graded-density: Graded-density particle board mats have finer particles on the surface, and the particle size grades evenly to the core, where the particles are coarser. The mats of this kind are produced in the following way:

1. The fine particles (fines) are thrown further than the coarser particles, as they pass through the wind sifter.
2. The fines are the first to land on the advancing mat former.
3. As the mat former moves on, the fines are covered by particles of gradually increasing size.
4. The other half of the spreader does this in reverse. The coarse particles arrive first, and they are covered by particles which become finer.

In this way a graded mat is formed with fine particles on both surfaces, which grade evenly to the coarsest particles in the core.

Pressing

The formed mats are transferred to the hot press for pressing and curing. Before hot pressing, the mats may be pre-pressed cold to make them easier to transport. Single-daylight (opening) or multi-daylight hot presses can be used. The multi-daylight press can press many boards at once. As soon as heat is applied, the glue curing process begins. Full pressure is quickly applied to reach the desired thickness before curing occurs.

Finishing

The hot boards are removed from the press and treated in order to:

- Stabilise the moisture content of the board.
- Stabilise and fully cure the resin.

The panels are then trimmed and sanded on both surfaces to specified thicknesses.

Working properties

Particle board may be shaped by hand, or machined, in a similar manner to natural solid timber. However, since particle board contains synthetic resin adhesive, the cutting edges of tools become dull more quickly than they do when cutting timber. Therefore, the use of high-speed steel cutters or tungsten-carbide tipped cutters is often recommended.

Particle board can be nailed and screwed satisfactorily. However, nails and screws come out more easily than they do from solid timber. If possible, screws should be put only into face surfaces on particle board. To increase the holding power of screws in the edges of particle board, use long thread screws or edge-lip the board first with solid timber.

Uses

Particle board is used extensively by builders and furniture manufacturers because:

- It has uniform thickness.
- It has dimensional stability.
- It has good working qualities.
- It is availability in a large range of sizes.

In general, the building industry uses the single layer boards and the furniture industry uses the three-layer boards.

Hardboard

Hardboard is a panel material manufactured from natural timber fibres. It has many of the characteristics of natural timber. It does not have some of the physical disadvantages of timber: *e.g. There are no knots or natural grain structure to allow splitting.* Only hardboard uses lignin, the natural cohesive substances found in timber, to bind the fibre together.

Raw Materials

Low grade timber (particularly hardwood) is the main constituent. This may include straight logs, sound material from misshapen trees, and residues from timber mills: *e.g. Offcuts, dockings, etc.*

Most timbers have their own particular properties: *e.g. Long fibres, high water content, and colour.* Some of these properties are desirable and others are not.

Manufacture

Step 1 Logs are cut into billets approximately two metres long. Then the billets pass through a chipper, where the wood is cut diagonally across the grain into chips. These chips are screened for size. The oversize pieces are returned to be re-chipped and re-screened.

Step 2 The chips are then reduced to fibre by either of two defibrating processes:

- In the Mason-developed process (known as the 'explosion method'), the chips are loaded into high pressure steel cylinders called 'guns'. Pressurised steam enters the cylinder and then a valve is opened and the pressure is released. This sudden loss of pressure causes the moisture in the chips to vaporise. This vaporisation breaks down the ligno-cellulosic bond. As a result of the bond breaking down, the chips are blown apart into very coarse fibre.

- The 'machine defibrating' process involves a continuous flow of chips through the defibrators and refiners. The chips are passed into a pre-heater of pressurised steam to partially dilute the lignin bond. The heated chips are then passed between two large steel grinding discs; one disc is fixed, the other disc is rotating. The action of these two discs converts the chips into fibres. This 'fibrous mass' is further reduced to individual fibres in raffinator machines. In these machines, the fibres are washed, and at the same time, unwanted material is screened off.

Step 3 To form the mat, the fibres are held in a watery suspension of approximately two per cent solids.

Step 4 This liquid is sprayed onto a moving wire screen. At first, the excess water drains off by gravity. Then, as the conveyor continues its travel, suction boxes drain off more water.

Step 5 The screen finally passes between heavy rollers. These rollers remove more moisture by pressure, causing the fibres to 'mat' together. This mat is referred to as a 'wetlap'.

Step 6 The wetlap is cut into suitable lengths.

Step 7 The wetlap is transferred to the hot press. These high temperature and high pressure presses act as the catalyst between the lignin and the wood fibre. Each 'mattress' is squeezed between a screen and a highly polished platen.

Step 8 As heat and pressure are applied the remaining water changes to steam. The steam escapes through the screen. This causes the familiar mesh pattern on the back of many types of hardboards.

Step 9 The result is a hard, tough, dense and grainless sheet.

Classification

Hardboard may be divided into three categories:

- Natural hardboard. This includes standard and tempered (high density) hardboard.
- Primed hardboards.
- Pre-finished and perforated hardboard. This includes a range of finishes and treatments.

Natural hardboards

Standard hardboard:

These are the boards that are generally used for wall and ceiling linings, and furniture construction. It is also the board produced in the greatest quantity, as it has proved most acceptable to both the tradesperson and the amateur. Standard hardboard has a relatively high strength factor and is resistant to water.

Tempered hardboard:
This type of hardboard is produced by soaking standard panels in various oils. The soaked panels are then re-baked to lock in the absorbed oil. This produces a panel that is harder, stronger, smoother, and more water-resistant than the standard board. This board is useful in situations where moisture-resistance is required, such as kitchens and laundries.

Special tempered and thicker hardboard is available for vertical or flat forming, where smooth concrete surfaces are required.

Primed hardboards
These are natural hardboards, which have been sealed with paints to limit the porosity or 'soaking up' qualities of the board surface. The resin-based primer enables the board to be re-coated with commonly used paints.

Pre-finished hardboards
These refer to the various surface finishes, which may be applied to the natural hardboard. Surface treatments such as timber veneer, plastic film, plastic laminate, and metal cladding have been successfully applied to the appropriate hardboard surfaces. Some examples are:

Perforated hardboards:
Perforated hardboards have patterns of holes punched in them. They are die-punched under power presses to standard patterns. They are available in standard or tempered boards, and in a wide range of painted finishes.

Sandwich panels:
Hardboard cladding outside a core material provides an efficient sandwich panel which has numerous uses. The building industry, for example, uses these sandwich panels where good acoustic and thermal properties are required, as well as a high-strength-to-weight ratio. Core materials include particle board, honeycomb paper, polyurethane and polystyrene.

Preservation Of Timber

Timber species vary a lot in their structure and natural chemical components. Each species has its own cellular structure. This cellular structure determines its natural ability to take up preservative chemicals. Like many other commercially available timbers, untreated pine may have poor durability in exposed conditions, or under attack by insects or fungi.

Types of preservative

Three classes of preservatives are commonly used for the pressure treatment of pine timber:

- *Water-borne* (copper, chrome, arsenic [CCA]).

  CCA preservative is by far the most widely used preservative for the treatment of pine timber. The copper acts as a fungicide and the arsenic is an insecticide. Chrome is included to fix the copper and arsenic so that they will not be leached from the timber.

  Wood treated with CCA is clean, odourless, has a slight green colour and is able to be glued and painted when dry.

- *Solvent-borne* (Light organic solvent preservative [LOSP]).

  Light organic solvent preservative refers to the solvent carrier in the treatment process. The actual preservative is a solution of various organic fungicides and insecticides. LOSP treated pine provides long lasting protection against decay and insect attack when used above the ground.

- *Oil-borne* (creosote).

  Creosote treated wood is highly water repellent and resistant to weathering. Therefore, it can be used in many situations which are highly hazardous to the timber — such as where termites are present.

  The surface of creosote treated timber is generally oily and black. It cannot be painted or glued. It remains oily to handle for some months after treatment and gives off a strong odour. It also has a tendency to 'bleed' preservative on to the wood surface. For these reasons the material is seldom used in buildings.

Classes of hazards

The following chart classifies the hazard class for timber treatments, the possible hazard, the type and degree of attack and suitable treatments for each hazard class.

HAZARD CLASSES

Hazard Class	Hazard	Exposure	Suitable Chemicals	Typical Uses
H1	Insects other than termites	Inside, above ground	**CCA LOSP**	Flooring, interior joinery, furniture
H2	Termites Borers	Inside, above ground	**CCA LOSP**	Framing,Flooring
H3	Moderate decay, borers, termites	Outside, above ground	**CCA LOSP**	Cladding, fascia, pergolas, decking
H4	Severe decay, borers, termites	Outside, in ground	**CCA, LOSP, Creosote**	Fence posts, pergolas
H5	Very severe decay, borers and termites	Outside, in ground	**CCA, Creosote**	House stumps, building poles

Unit 5: BUILDING TERMINOLOGY

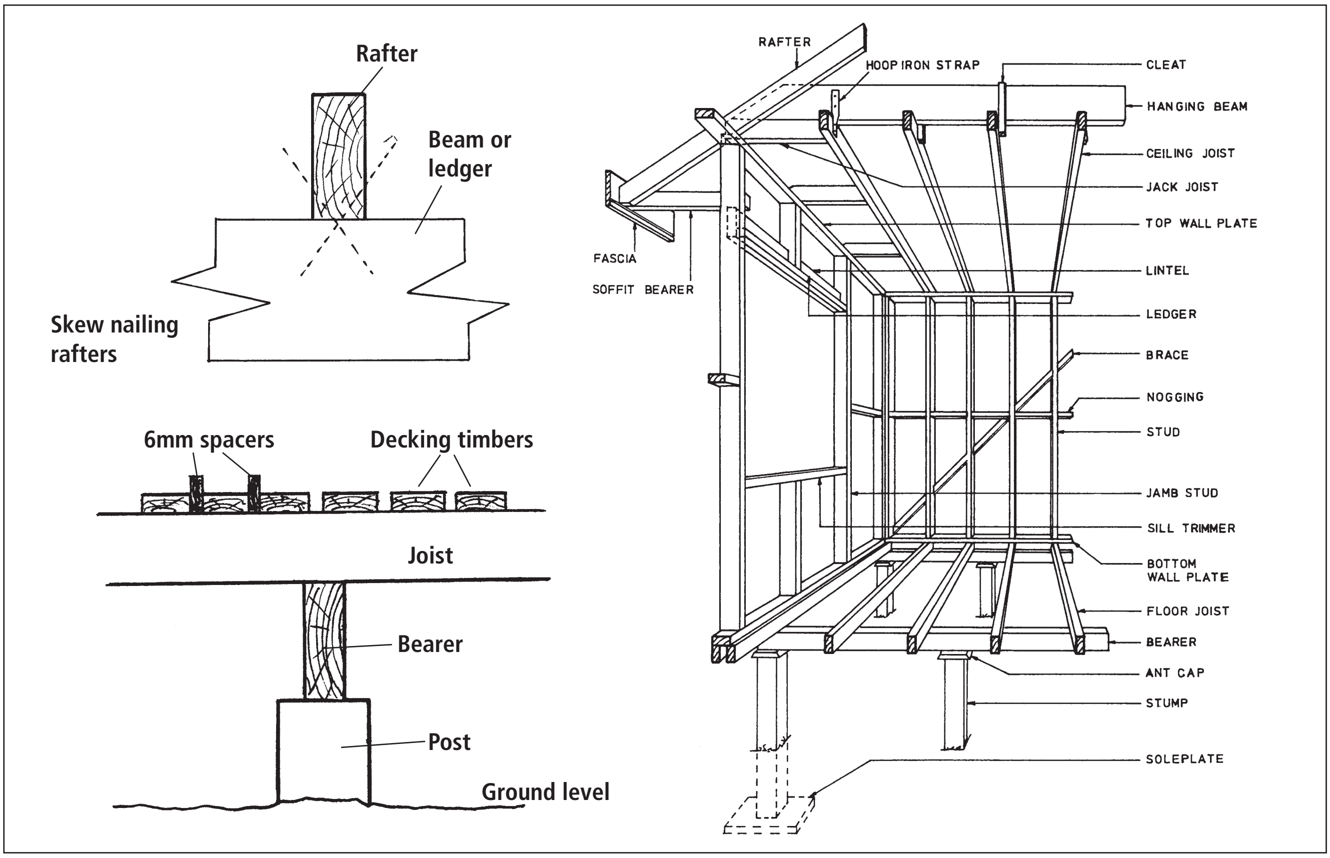


Figure 5.1
Building terminology.

Objectives
At the end of this unit you should be able to:

- Understand the terminology associated with building construction.

Introduction

In order to design and build outdoor structures you need to understand some of the terminology (technical words) and methods used in the construction industry. This unit introduces and describes terminology relating to the building process.

Foundations And Footings

The term **foundation** refers to the natural material of the site on which the structure rests, while the term **footings** refers to the lowest load-bearing part of a structure. Usually the footings are below ground level.

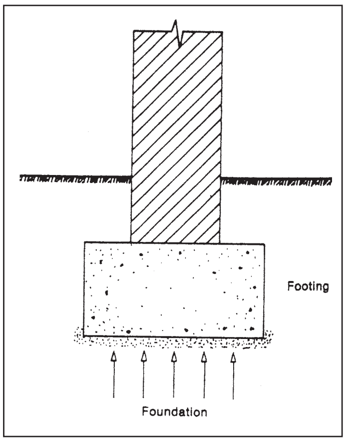


Figure 5.2
Foundations and footings.

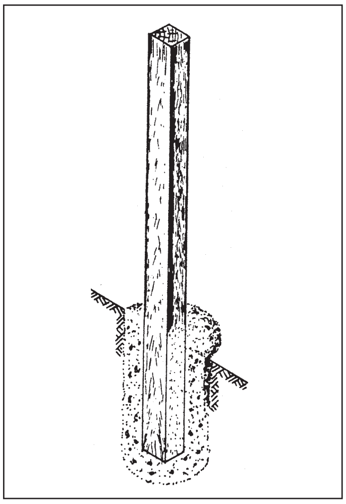


Figure 5.3
Post in ground.

Post footings

- *Posts in ground*:
  Timber posts must be suitable for setting into the ground: *e.g. Treated radiata pine.* They may be supported above ground level, or embedded (buried) to a depth of not less than one third of their height above ground. The minimum depth is 450 mm: *e.g. A post which measures two metres above the ground must have 670 mm (one third of two metres) below the ground.*

  Posts may be set directly into the ground with the earth tamped firmly around the post. Or, they may rest on a concrete footing which has a mix of 4:2:1 (gravel: sand: cement).

  Post holes must be back filled with suitable materials. The material should be added in 75 mm layers, and each layer must be well rammed. Suitable filling materials include earth without clay, gravel or a cement-soil mixture of 1:6 proportions.

  Where softwood posts are being used: *e.g. Treated radiata pine* it is essential that the timber has been treated with a chemical solution containing a fungicide and an insecticide: *e.g. CCA.*

- *Posts on concrete:*
  If a concrete slab is poured for the floor, the posts are usually attached to the slab rather than embedded in the ground. This is done by setting galvanised steel brackets into footings at ground level. The posts are bolted to the steel brackets. These brackets (post anchors) are available from most building suppliers, and come in a variety of styles and sizes.

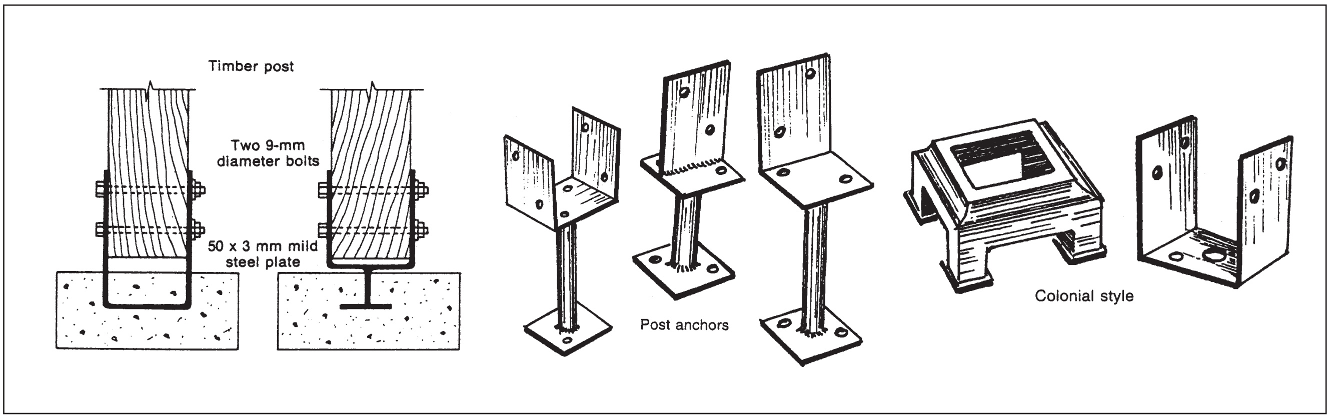


Figure 5.4
Posts in concrete.

Timber Framing

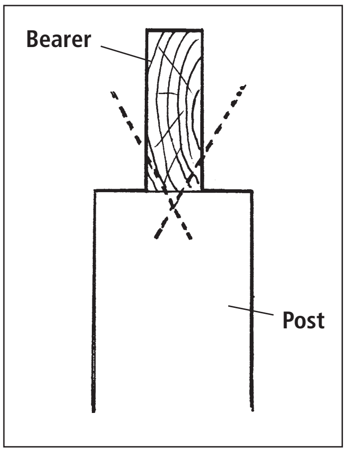


Figure 5.5
Skew nailing.

Skew Nailing
Nails that are driven in at an angle to the surface to give greater holding power.

Joists
These timbers are smaller in cross section than bearers (between 90 × 45 mm and 140 × 45 mm). Joists rest on the top of the bearers or posts by skew nailing, or special fasteners such as a joist strap.

Ledger
This is a supporting timber attached to an existing building to support a new structure: *e.g. Deck joists or rafters.*

Bearers
These are pieces of timber (timber members) which support joists in timber frame constructions such as decks. They may be solid timber (90 × 70 mm) in cross section, double spaced or nailed laminated sections (190 × 35 mm).

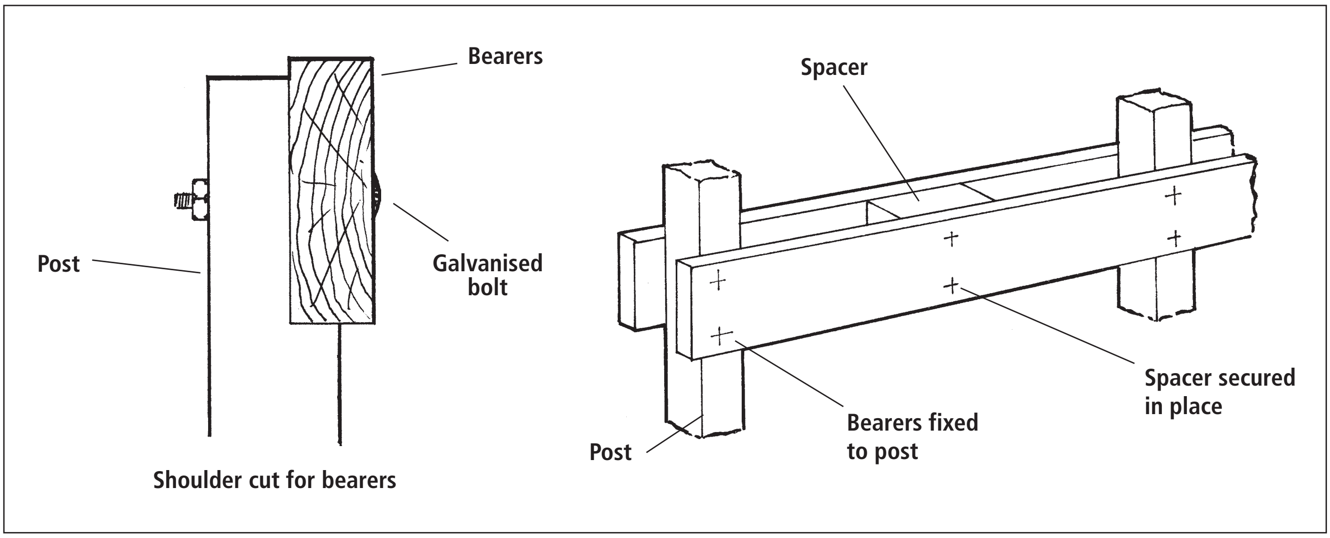


Figure 5.6
Bearers.

Bearers should be placed over the tops of posts. Double spaced bearers can be bolted to posts with galvanised bolts.

Decking

Pressure treated radiata pine is a suitable timber to be used for decking. All decking timbers should be dry when used (below 15 per cent moisture content). They should be dressed on at least one face and both edges.

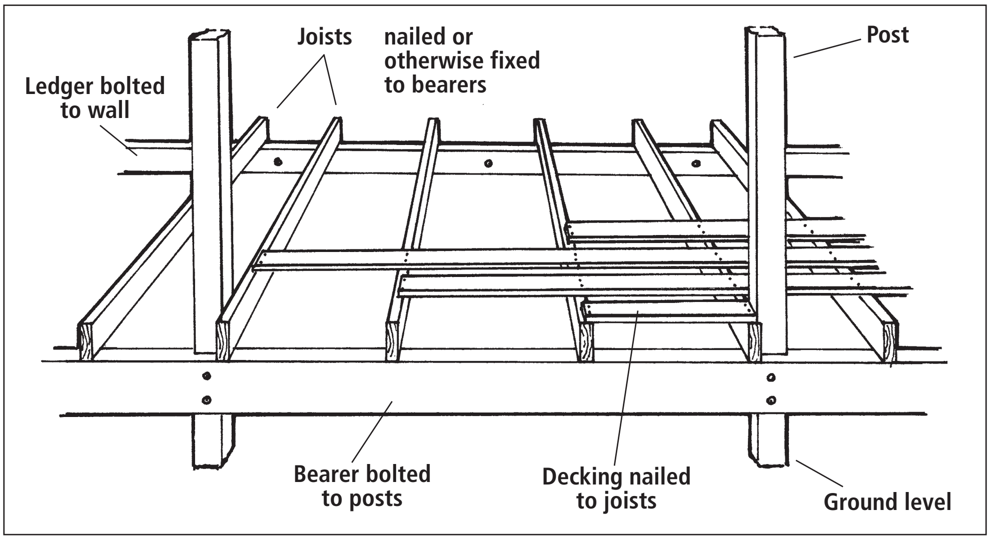


Figure 5.7
Decking.

Decking sections are used on flat, instead of on edge, and spaced up to 10 mm apart. They are supported at each end and at intermediate joists.

Beams

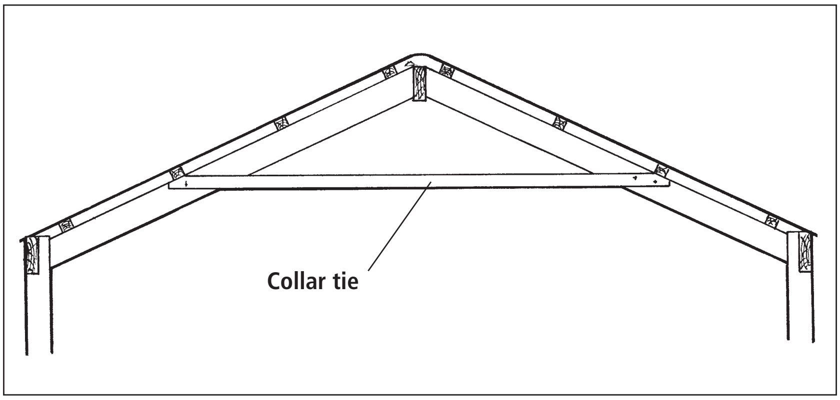
Beams are similar in cross section to bearers. They are used for supporting rafters in roof construction and sometimes support floor joists over larger distances than normal.

Ridge

This is the top horizontal member in a roof. It supports the rafters.

Rafters

These are the timber members of a roof that are inclined on an angle. They help to support the roof covering. They are found on flat roof structures, or may be attached to a ridge board where a gable roof is being constructed.



Collar ties

They are horizontal timber members that connect rafters opposite each other, in order to brace them. This prevents sagging and other movement. They are generally bolted to the rafters.

Figure 5.8
Collar tie.

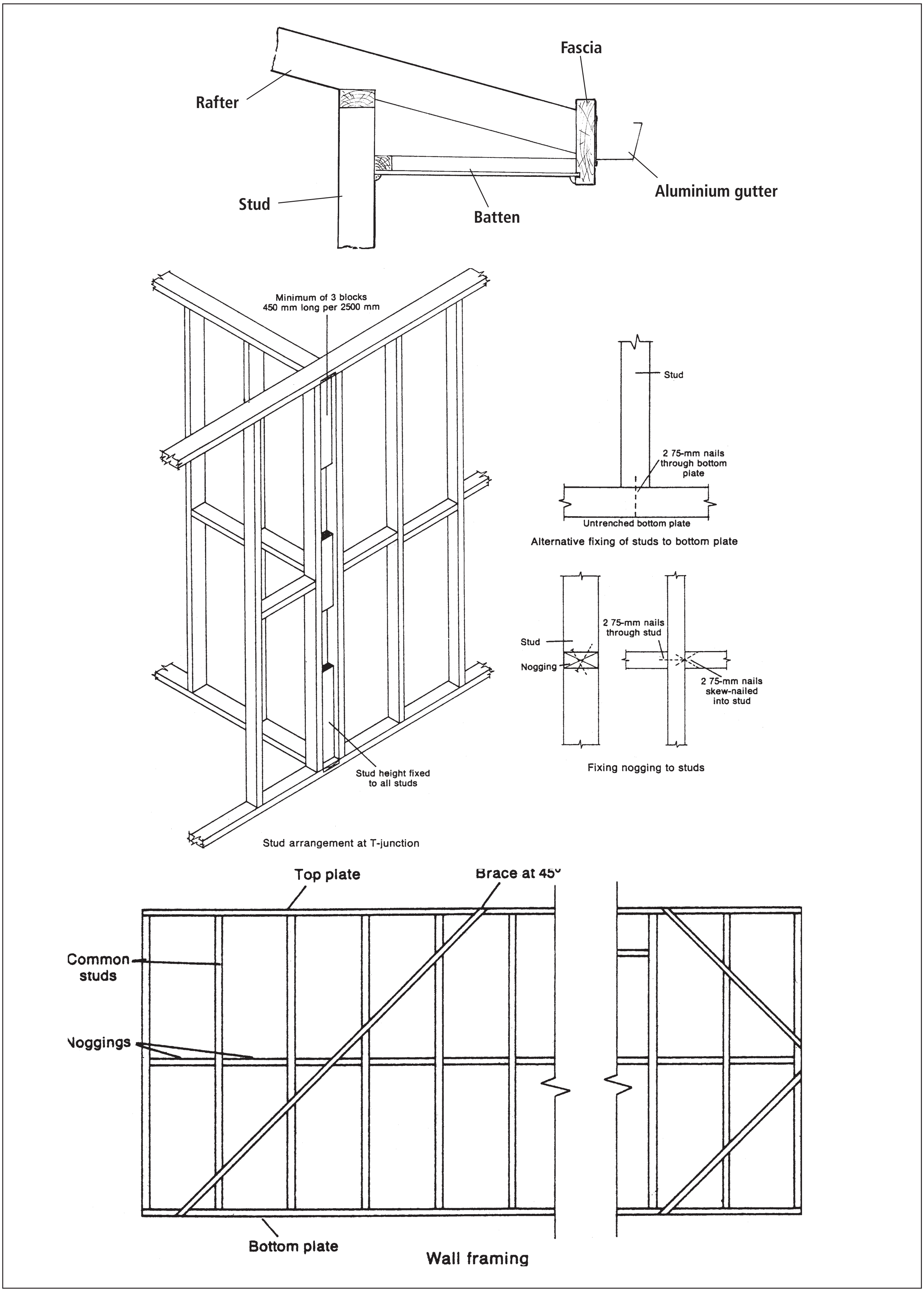


Figure 5.9
Timber framing.

Fascia

This is the upright piece of timber which is attached to the ends of the rafters to carry the guttering.

Battens

Timbers of small section (75 × 25 mm) generally spaced at a maximum of 900 mm from centre to centre. They are fixed to the rafters so that roofing materials can be attached to them.

Plates

These are horizontal members in structural framework. When constructing stud walls, these members form the top and bottom plates. The positions of the studs (vertical pieces) are marked and checked out on the top and bottom plates.

Studs

These are the upright members of a timber frame. They fit between the top and bottom plates.

Noggings

These are short horizontal pieces of timber which are fixed between studs. Plasterboard, skirting, etc. is attached to the noggings.

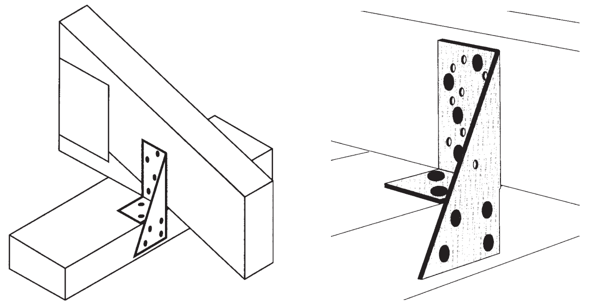
Bracing

These are generally metal straps which are fixed diagonally across a stud wall. They may be either in compression or tension.

Timber Framing Anchors

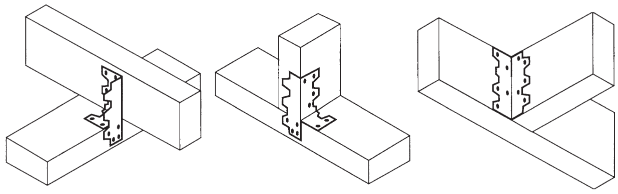
Traditional jointing techniques for outdoor structures are skew nailing, bolting and screwing. Now there is a large range of special timber framing anchors (angled steel plates) available that simplify structural jointing in timber roof, ceiling and floor framing. They have been designed to rigid specifications including load ratings and wind uplift. They have greatly simplified the assembly and construction of decks and basic shelters.

The following is a selection of timber anchors that you could consider using when you are designing and building an outdoor structure.



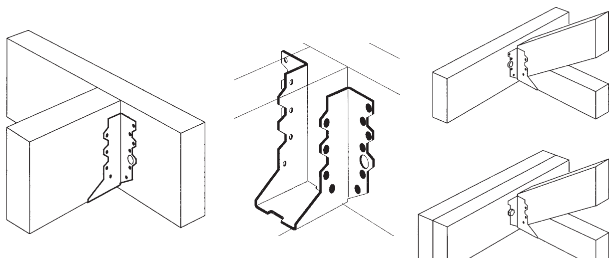
Triple-L-Grip

Trip-L-Grip Developed as an economical and simple connector for jointing in timber roof, wall, ceiling and floor framing. Available in left or right hand.



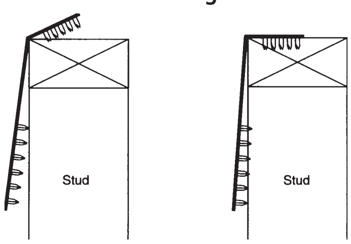
Universal Trip-L-Grip

Universal Trip-L-Grip Designed to allow bending and forming on the job. These are suitable for a wide variety of applications.



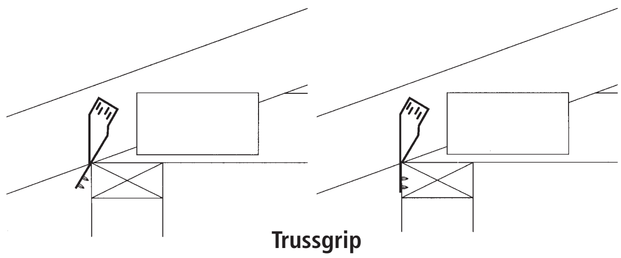
Joist hanger

Joist hanger Used to fasten joists to the face of beams in both floor and roof situations. Available in a range of sizes to suit most common timber dimensions (both dressed and rough sawn material).



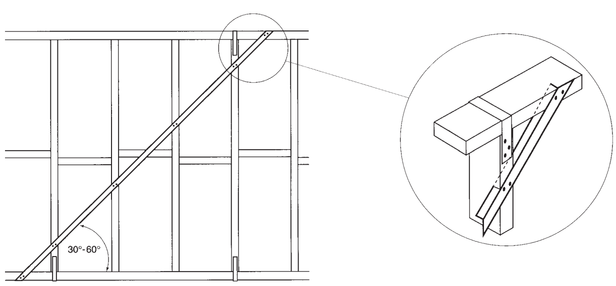
Stud strap

Stud strap Designed to secure timber top and bottom plates to studs in high wind areas.



Trussgrip

Trussgrip Designed to anchor timber trusses to wall top plates. Trussgrips are designed to be hammered into the timber without the use of nails.



Maxibrace

Maxibrace Designed to brace timber framed walls in domestic construction. Maxibrace is effective both as a compression or tension bracing system.

Angles

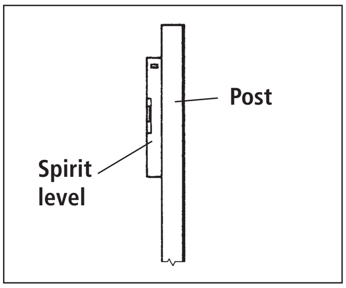


Figure 5.10
Plumbing a post.

Pitch
The function of the roof is to exclude weather and therefore it must be designed to shed rainwater. This means that the roof must slope at an angle (the pitch of the roof). Even a roof which is described as a flat roof has a pitch. A flat roof is anything less than 5° pitch. A low pitch is between 5° and 22°.

Plumb
To make perpendicular.

Try square
A tool used to check and mark right angles in building work.

Laying Concrete

Boxing Up
Making hollow boxes to pour concrete into.

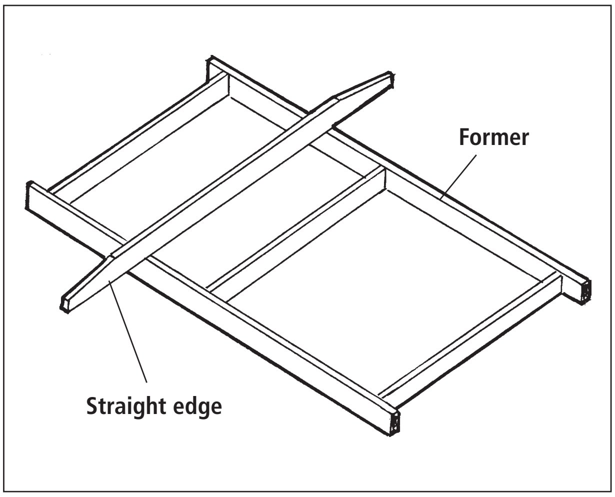


Figure 5.11
Boxing up for a path.

Former
The boxing in which footings, paths, floors, etc. are cast. A temporary box of timber with an open top is constructed. The liquid concrete is poured in to set. Then the boxing is removed

Straight Edge
A length of timber with parallel, straight edges. It is often used for levelling concrete.

Screeding
The process of using a straight edge (a screed) to level out concrete which has been poured into a former.

Edging Tool
A small steel tool used for grooving the edges of concrete,

Grooving Tool
A small steel tool used for grooving the internal sections of concrete.

Trowel
A wooden or steel based tool with a handle used for finishing the surface of concrete.

Unit 6: DESIGNING AND CONSTRUCTING A TIMBER DECK

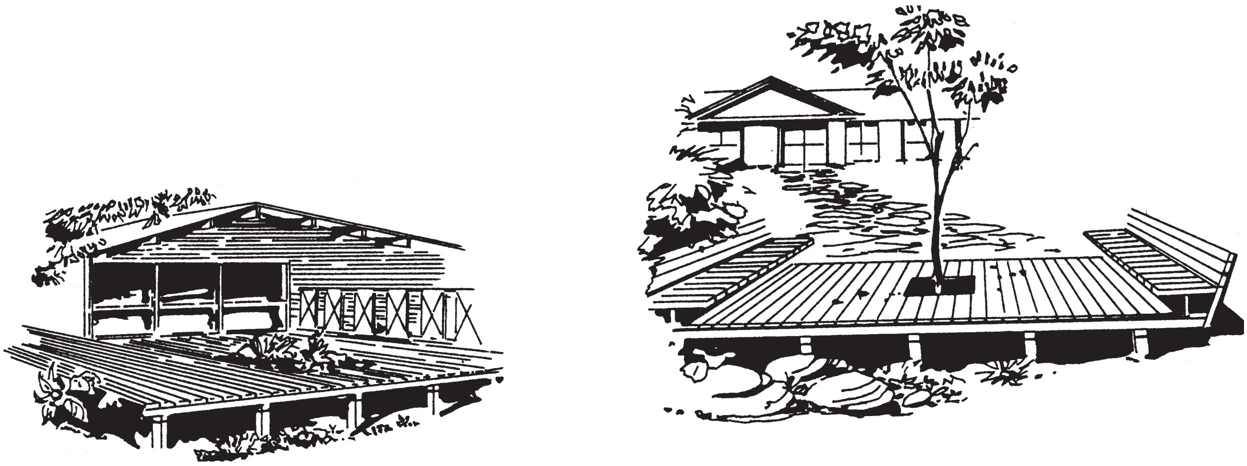


Figure 6.1
Timber decks.

Objectives
By the end of this unit you should be able to:

- Investigate and critique a range of timber structures.
- Develop a series of concept sketches leading to a set of working drawings.
- Build the designed structure, working as a team member.
- Evaluate the final outcome.

This will include:

- Selecting appropriate materials.
- Preparing a suitable site.
- Securing posts in the ground.
- Attaching bearers and joists to posts.
- Applying a suitable finish to the decking timber and exposed framework.
- Safely using an appropriate range of hand and power tools suitable for use in deck construction.

Introduction

The function of any outdoor structure usually determines its design and location. The investigation stages of the building process should consider the following:

- The need to control sun, wind and rain.
- Drainage.
- Plumbing requirements.
- The relationship of the structure to any other buildings.
- The relationship of the structure to other activities.
- Possible environmental impacts.

Most outdoor structures, like houses, are basically rectangular in plan. There are many design variations, using a range of materials, but all have similar basic constructional components. In most areas, approval is required for any type of outdoor structure from the local council. To get approval to build, you will need to submit a plan showing the location of the structure, its overall size, timber dimensions, joint structures and footing details.

Selecting The Timber

Materials required:
Reference books/ pamphlets giving information on qualities and characteristics of suitable timbers available locally.

Posts
The timber best suited for setting into the ground is pressure preservative-treated radiata pine. Treated radiata pine may be used in rounds or as sawn timber.

Sub structure timbers
Joists, beams and bearers can also be of pressure treated radiata pine if they are to be stained or left unfinished.

Decking timbers
Pressure treated radiata pine is a suitable timber to be used for decking. All decking timbers should be dry when used (moisture content below 15 per cent). They should be dressed on one face and two edges.

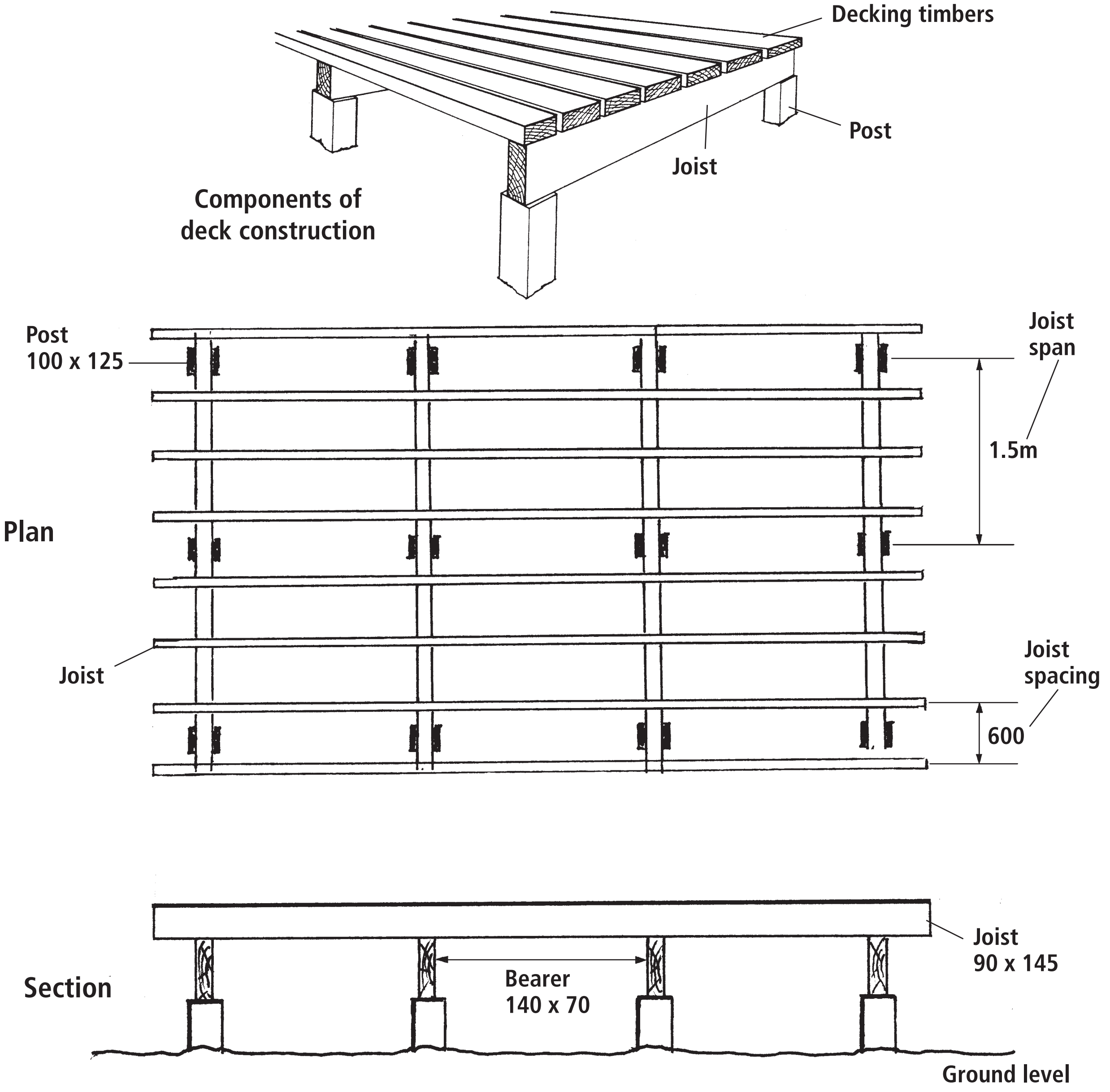


Figure 6.2
Timber deck.

Timber Sizes

The following suggested sizes are based on pressure treated radiata pine (minimum stress grade F5)

Table 1

Posts Sizes (mm) 90 × 90 100 × 125	Maximum post height (m) 2.4 2.4	
Bearers Size (mm) 120 × 70 140 × 70	Span (m) 1.5 1.8	Spacing (m) 1.8–2.4 1.8–2.4
Joists Size (mm) 90 × 45 140 × 45	Span (m) 1.8 2.4	Spacing (mm) 600 600
Decking Size (mm) 19 or 22	Maximum span (mm) 460	

Site Preparation

Materials required:
Coarse gravel;
Plastic sheeting;
Agricultural pipe.

Tools required:
Shovel;
Spade;
Wheelbarrow;
Pickaxe;
Rake;
Mattock;
Garden spray.

Deck sites need good drainage to avoid soil erosion and footing movement. Erosion and movement can be caused by flooding and by excessive water in the soil. Some improvement in natural drainage can be made by constructing rock filled trenches, or agricultural drains. Posts and stumps should be protected from water lying against their surfaces.

Where weeds may be a problem under low decks, it is wise to treat the soil with a herbicide before beginning construction. Alternatively, plastic sheeting may be laid after the stumps/posts have been set in place. A layer of crushed rock or pine bark may be needed to hold the plastic sheeting in place.

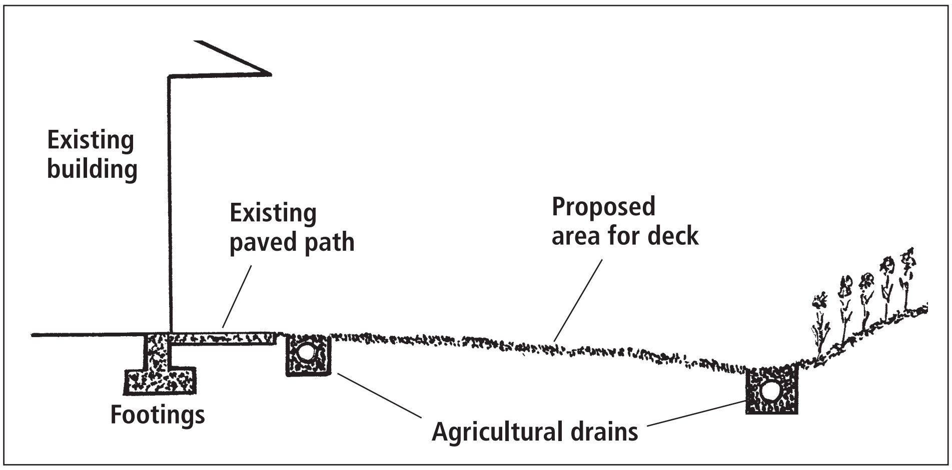


Figure 6.3
Site preparation.

Setting Out

Materials required:
Metal or timber pegs.

Tools required:
String line;
Hammer;
Extension tape.

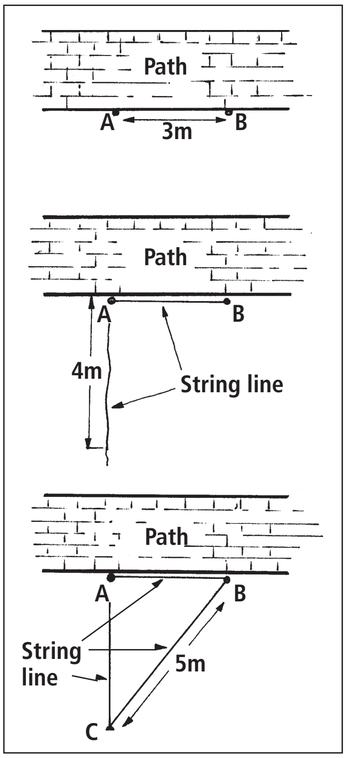


Figure 6.4
The 3–4–5 method.

If the deck is to be positioned alongside a building, it is best to make it freestanding. It may be very close to the building and appear attached, but it is free to allow for minor movement and settling.

When you are setting posts into the ground, use the 3–4–5 method to get true right-angled corners.

The 3–4–5 method

Step 1 First, establish one side (wall of the building, a path or fence) and drive two pegs, A and B, into the ground three metres apart.

Step 2 Attach a string line four metres (4 m) long to peg A.

Step 3 Lay out the string approximately at right angles from the peg A.

Step 4 Attach another string line five metres (5 m) long, to peg B.

Step 5 Pull the 5 m string line from peg B tight, until it meets the 4 m string line from peg A.

Step 6 At the meeting point drive another peg, C, into the ground.

Step 7 The angle CAB is a perfect right angle.

Step 8 Other footings or post positions can be located in the same way.

From the timber sizes table on page 53, select the appropriate size posts, bearers, joists and decking timbers suitable for your design.

Using the 3–4–5 method as described above, lay out the positions of the posts as shown in Figure 6.5 below.

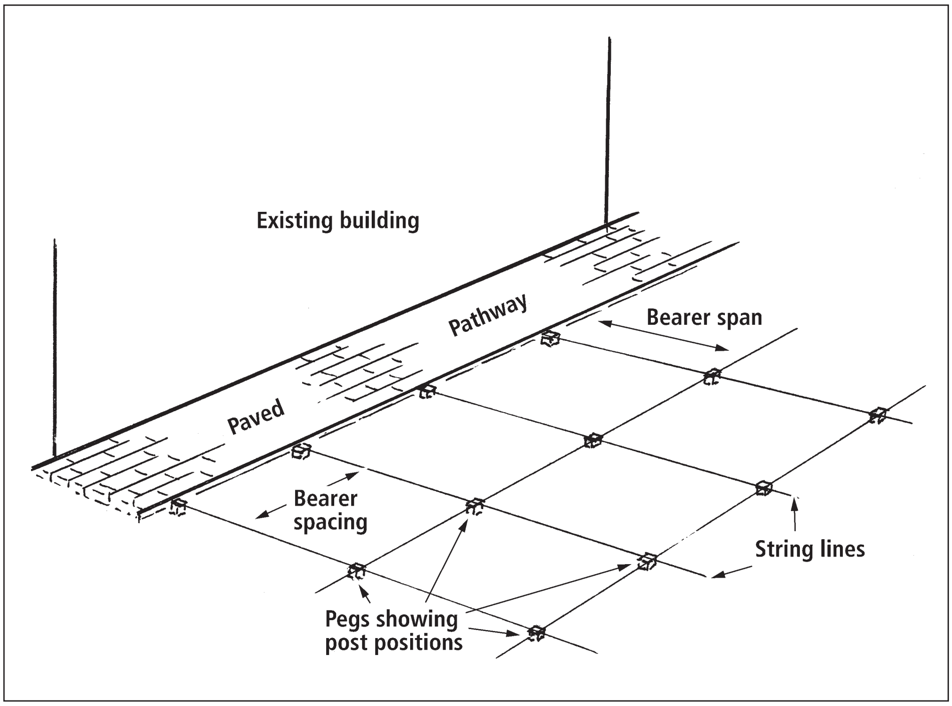


Figure 6.5
Setting out the site.

Footings And Posts

Materials required:
Cement;
Sand and gravel;
Backfill material.

Tools required:
Post-hole digger;
Spade;
Crowbar;
Spirit level;
Panel saw.

Timber posts suitable for setting into the ground, may be supported above ground level, or embedded to a depth not less than one third of their height above ground. The minimum depth is 450 mm.

For best results, posts embedded into the ground should rest on concrete footings. A concrete mix of 4:2:1 (gravel: sand: cement) is suitable for these footings. Be careful that the posts are plumb (vertical). They must be in the correct position during and after backfilling.

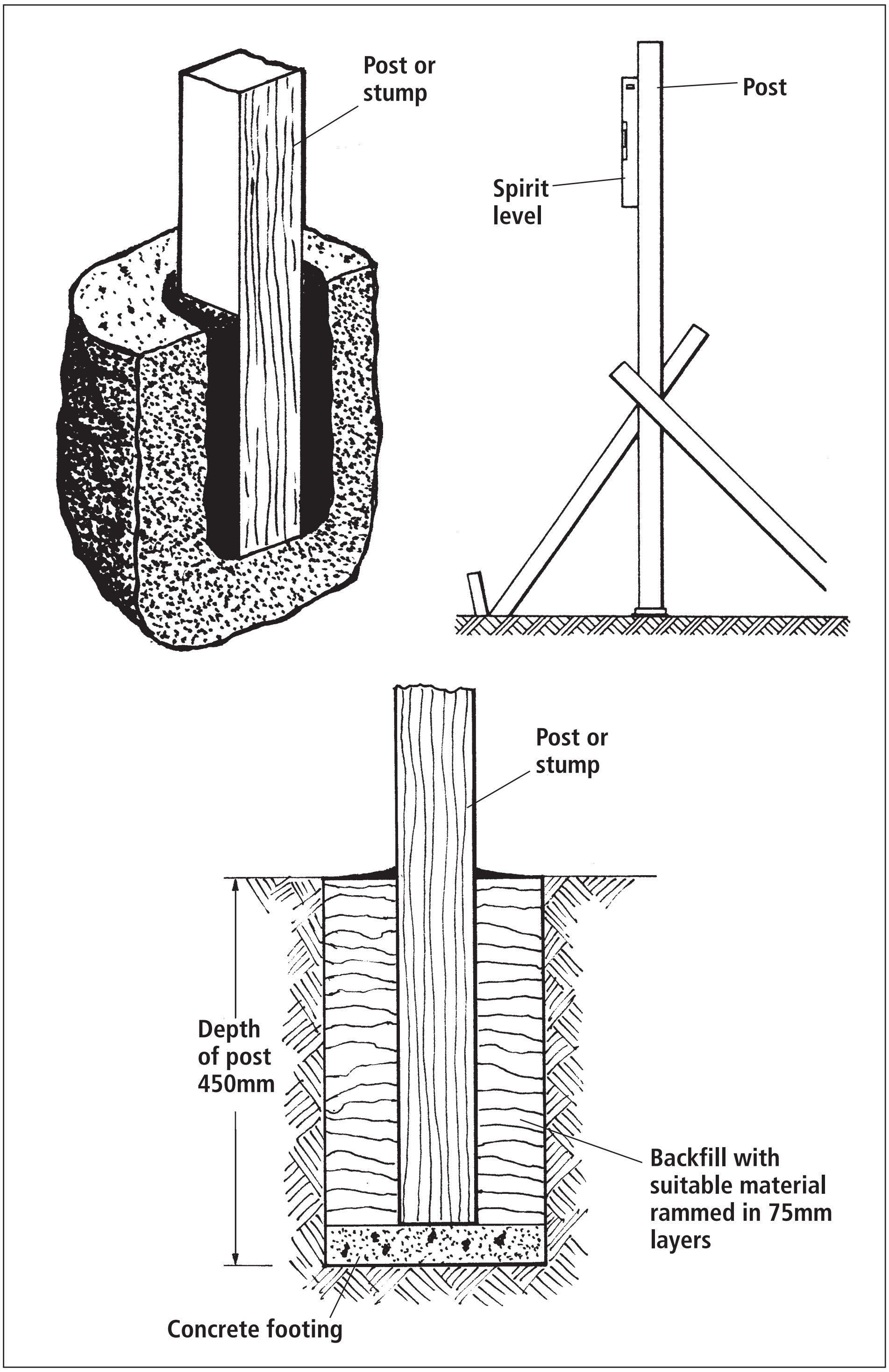


Figure 6.6
Footings and posts.

Bearers And Joists

Materials required:
Galvanised bolts;
Coated nails;
Metal fasteners.

Tools required:
Hammer;
Cordless drill;
Electric circular saw;
Panel saw;
Spirit level.

Bearers may be secured to posts by skew nailing, with galvanised bolts or with patented fasteners.

If skew nailing is used, first drill through the bearers at the appropriate angle, with a drill bit slightly bigger than the nail gauge, to prevent splitting of the bearer.

Double bearers may also be used provided they have small blocks of wood placed between them every 500 mm.

Shoulders may be cut on posts to provide support and location for bearers. (Figure 5.6, page 44.)

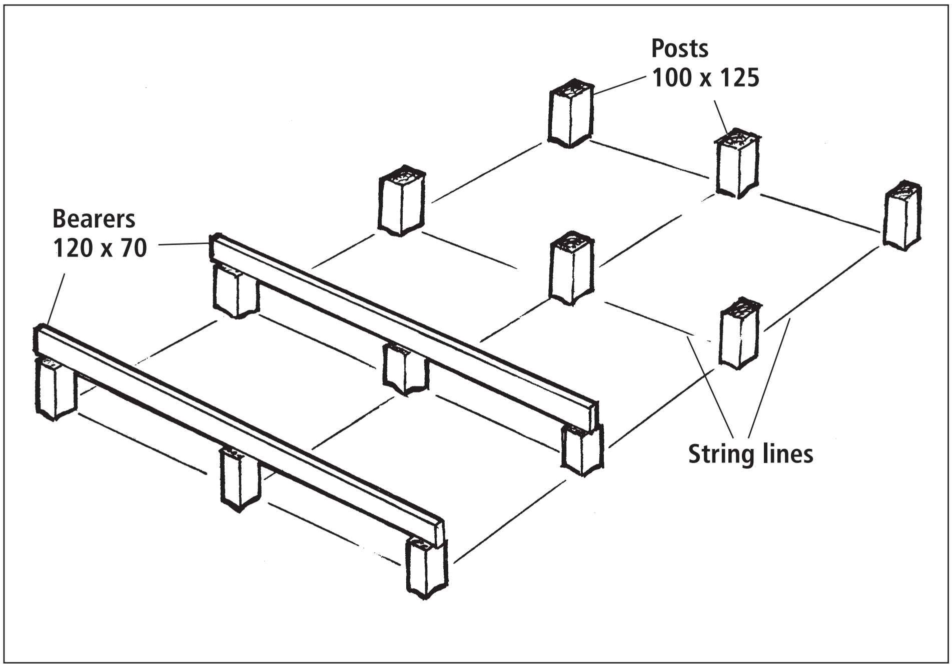


Figure 6.7
Bearers.

Decking

Materials required:
Non-ferrous nails;
Screws.

Tools required:
Hammer;
Cordless drill;
String line.

The boards (see decking profiles in Figure 6.8 below) are fixed to the joists with a gap of 4 mm to 6 mm separating the boards. A strip of wood of the required size can be used to check the spacing.

Fix the boards to the joists with nails or screws. Pre-drill the holes when you are nailing or screwing the ends of timbers which are likely to split. Galvanised or non-ferrous nails or screws will not stain the decking timber.

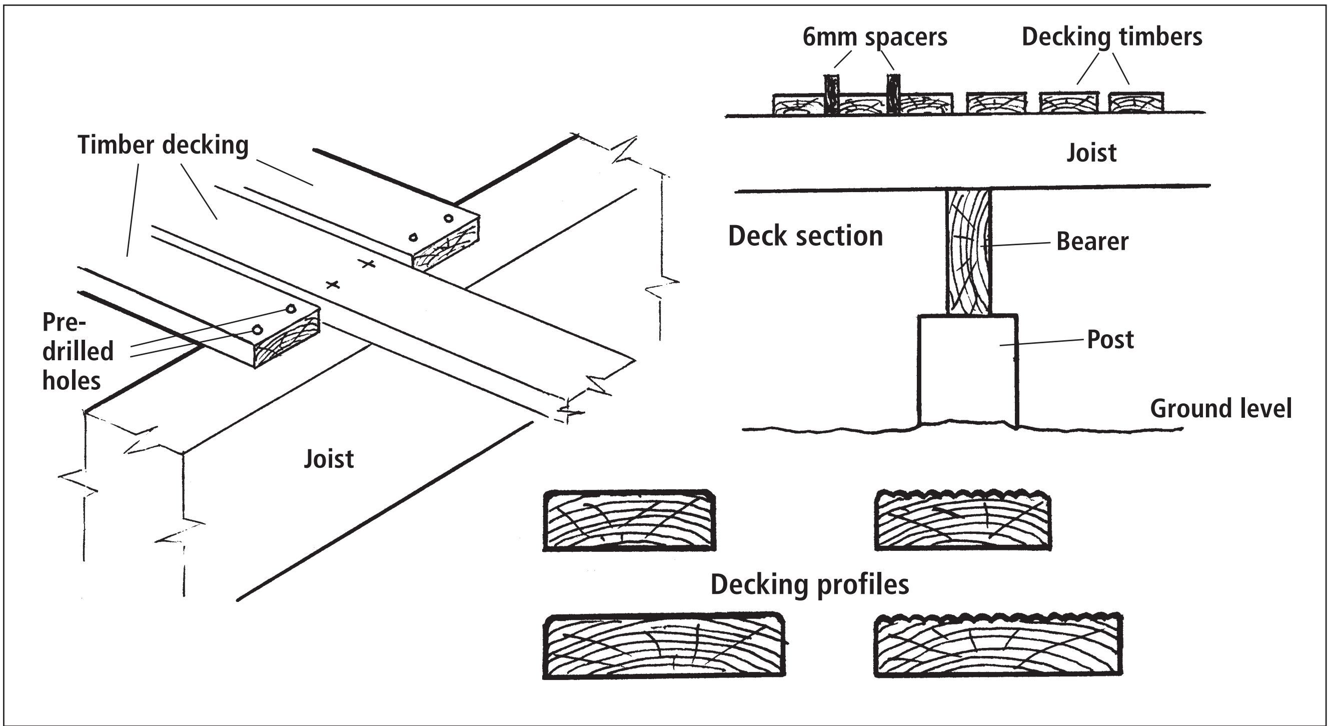


Figure 6.8
Decking.

Activity 1 Freestanding Or Attached Deck

Design and construct a freestanding or attached deck or similar structure. Use the sketches throughout this unit, as a starting point for your investigation.

Local building regulations and requirements need to be met. Refer to Table 1 on page 53 for timber sizes, spans, and spacings.

Detailed working drawings need to be submitted for approval before any construction begins.

Unit 7: DESIGNING AND CONSTRUCTING SHELTERS

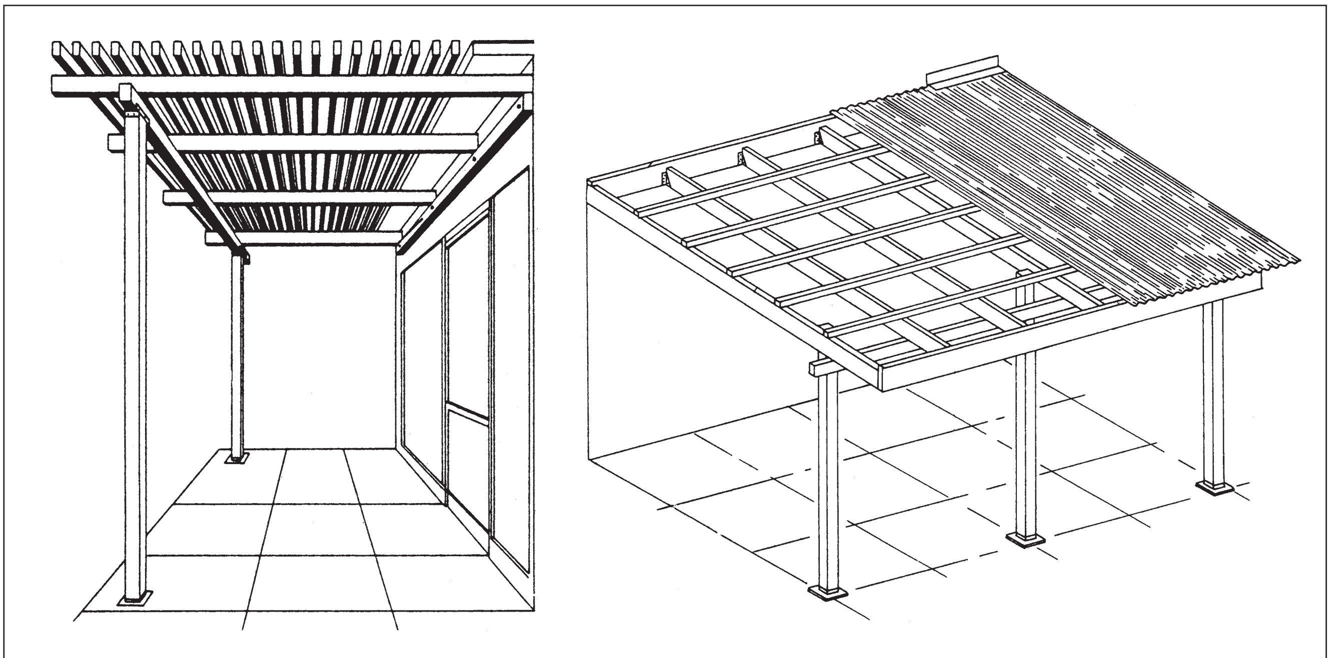


Figure 7.1
Basic framework for patio shelters and carports.

Objectives
By the end of this unit you should be able to:

- Investigate a variety of designs, sizes and materials for basic shelters.
- Develop a series of concept sketches leading to a working drawing.
- Build the designed structure, working as a team member.
- Evaluate the final outcome.

This will include:

- Selecting appropriate materials.
- Preparing a suitable site.
- Securing posts in the ground.
- Attaching ledgers to existing buildings.
- Securing beams to posts.

- Attaching rafters to ledgers and beams.
- Securing battens to rafters.
- Attaching appropriate sheeting material to make a roof.

Selecting The Timber

Materials required:
You will need reference material with information about qualities and characteristics of suitable structural timbers which are available locally.

Posts
The timber best suited for setting into the ground is pressure preservative-treated radiata pine. The same timber is also appropriate if you use post anchors, instead of setting the posts into the ground. However, it is good practice to seal the base of the posts with paint or a sealer to prevent rotting.

Structural timbers
Ledgers, rafters, beams and battens can also be of pressure treated radiata pine.

The information contained in Tables 2 and 3 is based on pressure treated radiata pine.

Table 2

Span (m)	**Rafters (mm)**	**Collar tie (mm)**	**Fascia beam (mm)**	**Ridge (mm)**	**Collar tie**	**Footing types (see Table 3)**	
MGP10					bolts	in sand	in clay
2.40	90 × 35	70 × 35	140 × 35	120 × 35	2-M10	3	1
3.00	120 × 35	70 × 35	190 × 45	140 × 35	2-M10	4	1
3.60	120 × 35	70 × 35	190 × 45	140 × 35	3-M10	4	1
4.20	140 × 35	120 × 35	190 × 45	190 × 35	3-M10	5	2
F5							
2.40	120 × 35	70 × 35	190 × 35	140 × 35	2-M10	3	1
3.00	120 × 35	90 × 35	190 × 35	140 × 35	2-M10	4	1
3.60	140 × 35	120 × 35	190 × 45	190 × 35	3-M10	4	1
4.40	140 × 45	90 × 45	240 × 45	190 × 35	3-M10	5	2
F7							
2.40	90 × 35	70 × 35	140 × 45	120 × 35	2-M10	3	1
3.00	120 × 35	70 × 35	190 × 35	140 × 35	2-M10	4	1
3.60	120 × 35	120 × 35	190 × 35	140 × 35	3-M10	4	1
4.20	140 × 35	90 × 45	190 × 45	190 × 35	3-M10	5	2

Note
MGP (machine graded pine).

Maximum design wind speed 41m/s.

190 × 35 mm rafter or fascia beam may be substituted for 140 × 45 mm.

Rafters and collar ties must not be spaced at greater than 1200 mm centres.

Sides must not be enclosed with walls without professional advice.

Washers must not be less than 22.5 diameter and 27.5 mm diameter for M10 and M12 bolts respectively.

Roof bracing is required for rafters that are pitched on top of fascia beams.

These structures are not designed to support heavy loads such as swings or earth filled pot plants.

For attached structures: Use 90 × 90 mm F7 posts at 3.0 m maximum centres

For freestanding structures (maximum height 2.4 m): Use 115 × 115 mm F7 LOSP posts at 2.4 maximum centres, on high wind post supports, to a maximum structure 'width' of 3.0 m.

Table 3

PAD FOOTINGS			
Type	Volume m^3	Square (mm)	Depth (mm)
1	0.054	300	600
2	0.096	400	600
3	0.150	500	600
4	0.216	600	600
5	0.270	600	750

General note
The timber sizes indicated in Table 2 are only for structures that are designed for light roof coverings such as polycarbonate sheet material.

Site Preparation

Material required:
Dolomite;
Sand.

Tools required:
String line;
Timber or metal pegs;
Hammer;
Extension tape;
Post-hole digger;
Pickaxe;
Shovel and spade;
Rake;
Mattock;
Wheelbarrow;
Spirit level.

In addition to the drainage requirements (see site preparation for a timber deck, page 53), shelters may have pavers or concrete areas laid underneath.

For pavers, the area needs to be 'dug out' to approximately 125 mm. This is to allow for two layers of base material: 75 mm of rubble or dolomite followed by 50 mm of sand. Both layers (rubble and sand) must be spread evenly and also tamped down firmly. Pavers are usually laid after the construction of the basic shelter has been completed.

If the area is to be concreted, the 'slab' may be laid before or after the basic shelter is constructed. For details on concreting see *Laying Concrete Floors* on page 78.

The surface of the pavers or concrete should slope slightly to ensure water run off. The slope should be formed when you are digging out the area and backfilling with dolomite and sand. As an approximate guide that the slope is correct, have the bubble in the spirit level sitting between $\frac{1}{4}$ and $\frac{1}{2}$ outside the two parallel lines on the glass vial.

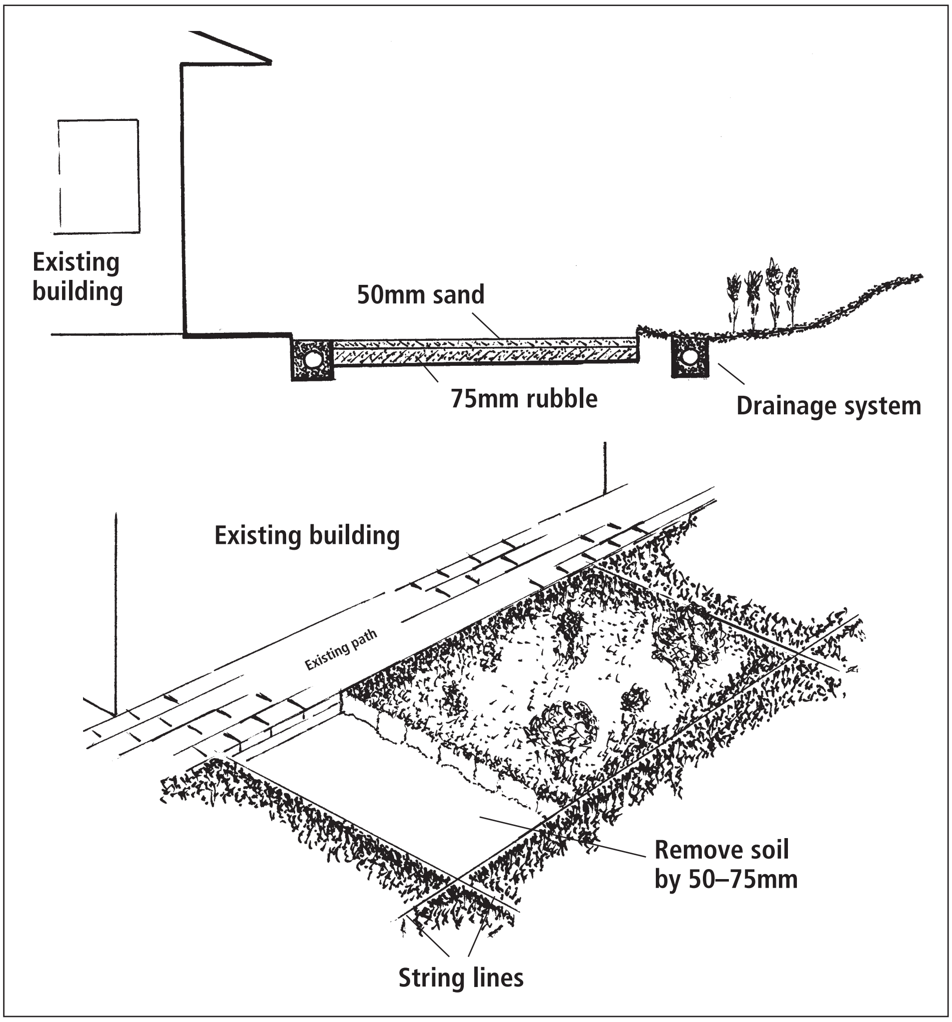


Figure 7.2
Site preparation.

Setting Out

Tools required:
String line;
Timber or metal pegs;
Hammer;
Extension tape;
Post-hole digger;
Spade.

1. Using the 3–4–5 method, establish the appropriate positions for the posts.
2. With a post-hole digger or spade, dig the holes to a minimum depth of 450 mm.
3. Mix a small batch of concrete using a 4:2:1 (gravel: sand: cement) ratio and place it in the bottom of each hole to provide a concrete footing for each post.

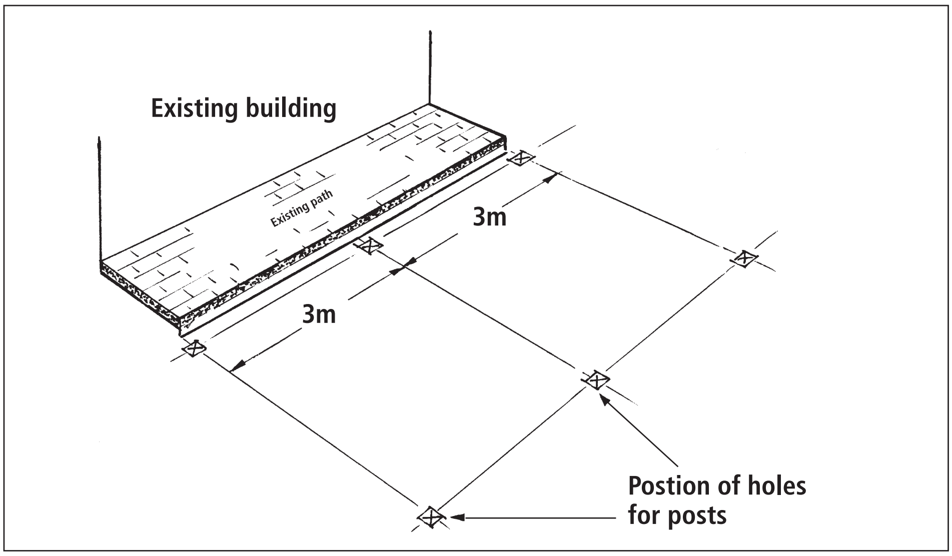


Figure 7.3
Setting out.

Footings And Posts

Materials required:
Cement;
Sand and gravel;
Water.

Tools required:
Extension tape;
Builders square;
Portable circular saw;
Panel saw;
Cordless drill;
Spirit level;
Hammer;
Shovel;
Crowbar;
Spanner set.

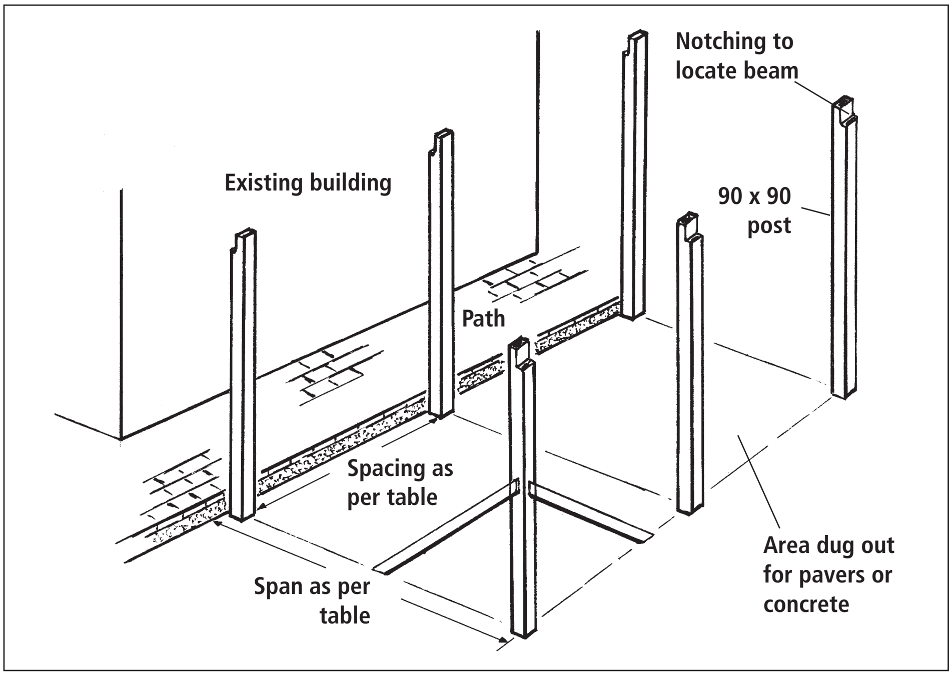


Figure 7.4
Standing posts.

Prepare the posts to the correct length using either a portable circular saw or a panel saw. Make a notch in the top of the posts. The notches allow the beam to be easily located and bolted to the post.

Attach the beams to each post. The posts are then lowered into the prepared holes. Using temporary timber braces and a level, 'plumb' each post to a vertical position and in line with each other. Be careful to check the distance from the path (or datum line) for each post. Mix another batch of concrete using 4:2:1 ratio and carefully cement each post into position and allow to dry.

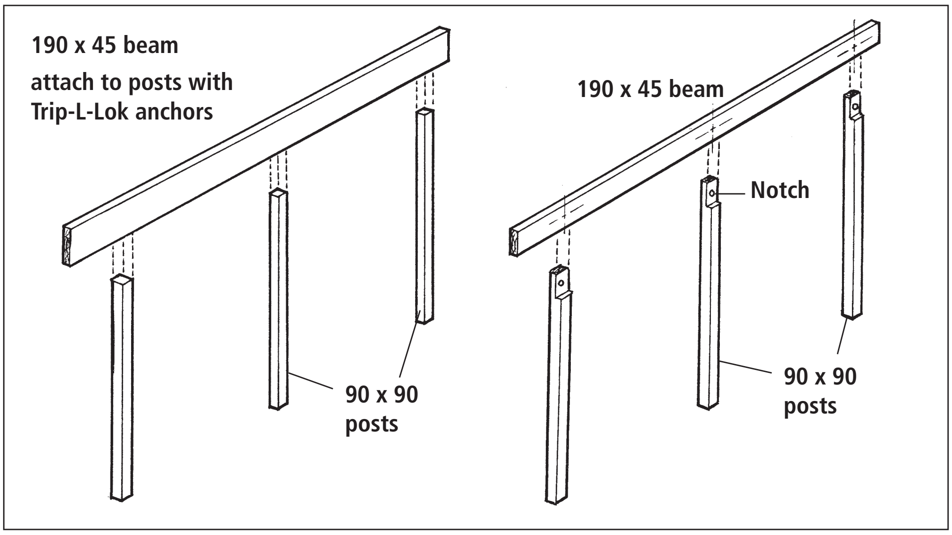


Figure 7.5
Attaching a beam to the top of posts.

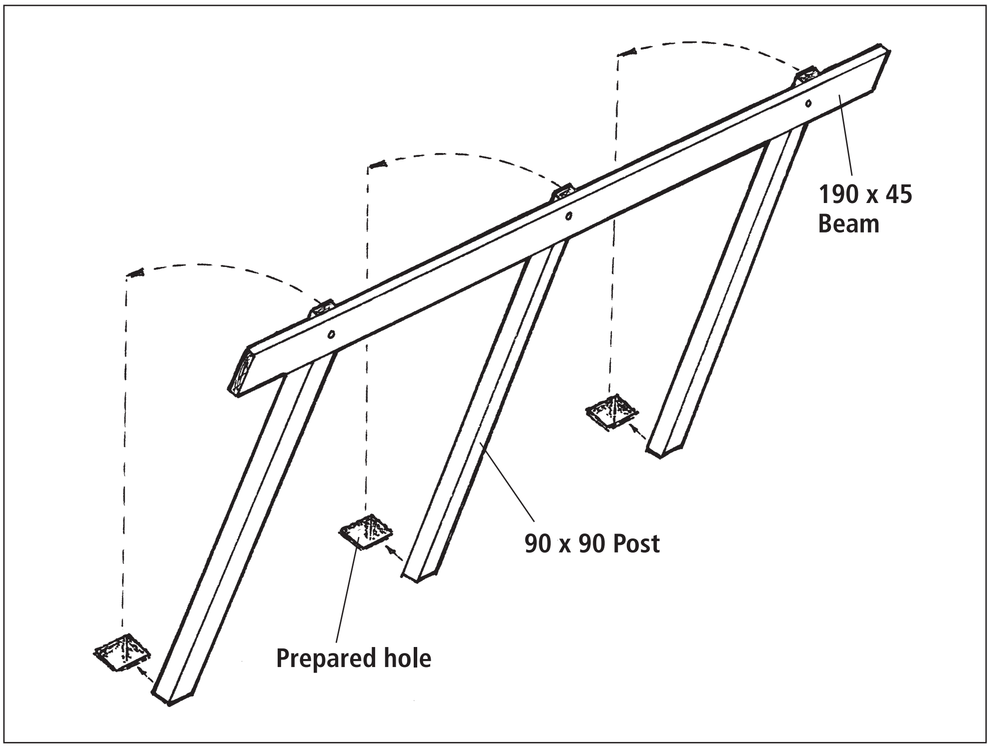


Figure 7.6
Standing posts and attached beams.

Rafters

Materials required:
Timber anchors;
Nails;
Galvanised bolts.

Tools required:
Portable circular saw;
Panel saw;
Try square;
Sliding bevel;
Cordless drill;
G clamp;
Hammer;
Spirit level;
Firmer chisel.

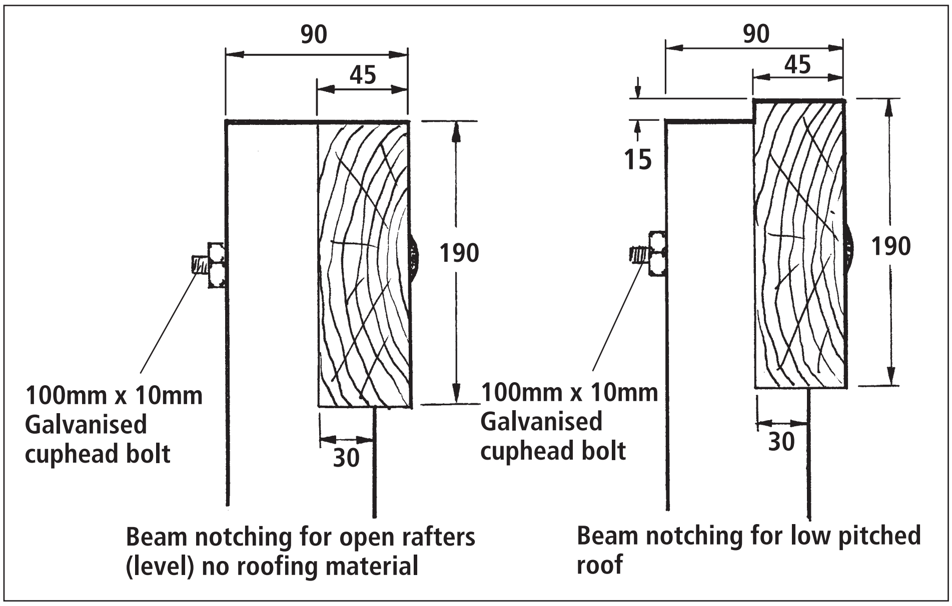


Figure 7.7
Notching beams into posts.

Usually with freestanding shelters the rafters sit on top of the beams or fascias, and are secured with timber anchors.

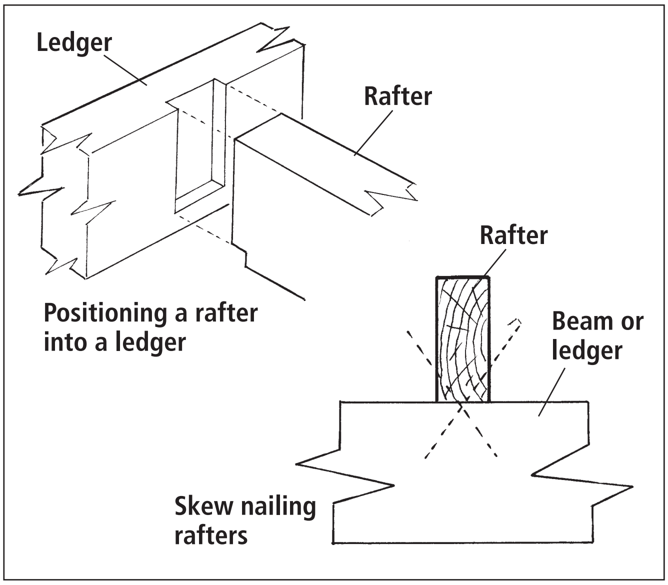


Figure 7.8
Rafters.

Where the structure is attached to an existing building the rafter may sit on top of the beam and ledger. Alternatively it can be located flush with the top of the ledger at one end and sits on top of the beam or fascia at the other. These rafters may be secured using timber anchors. Alternatively, where a ledger is used they can be supported from underneath with a timber batten attached to the ledger.

If the rafters are left protruding past the ends of the beams, it is a good idea to shape the ends. Shaping looks better and also reduces the amount of end grain exposed to the weather. This helps to prevent rotting.

Battens

Timber battens can be secured to the tops of the rafters and used for decoration, broken shade or as a means of attaching shade cloth or sheet roofing material. If sheet material is to be applied the battens need to be 70 × 45 mm. They should be fixed at 900 mm centres.

Activity 1 Freestanding Flat Roof Shelter

Materials required:
Cement;
Sand and gravel;
Water;
Timber anchors;
Nails;
Galvanised bolts.

Tools required:
Shovel;
Spade;
Post-hole digger;
Electric cement mixer;
Wheelbarrow;
Crowbar;
String line and pegs;
Portable circular saw;
Panel saw;
Cordless drill;
Hammer drill;
Spirit level;
Claw hammer;
G clamps;
Set of spanners;
Try square;
Builders square;
Extension tape;
Pencil;
Bevel square;
Step ladder.

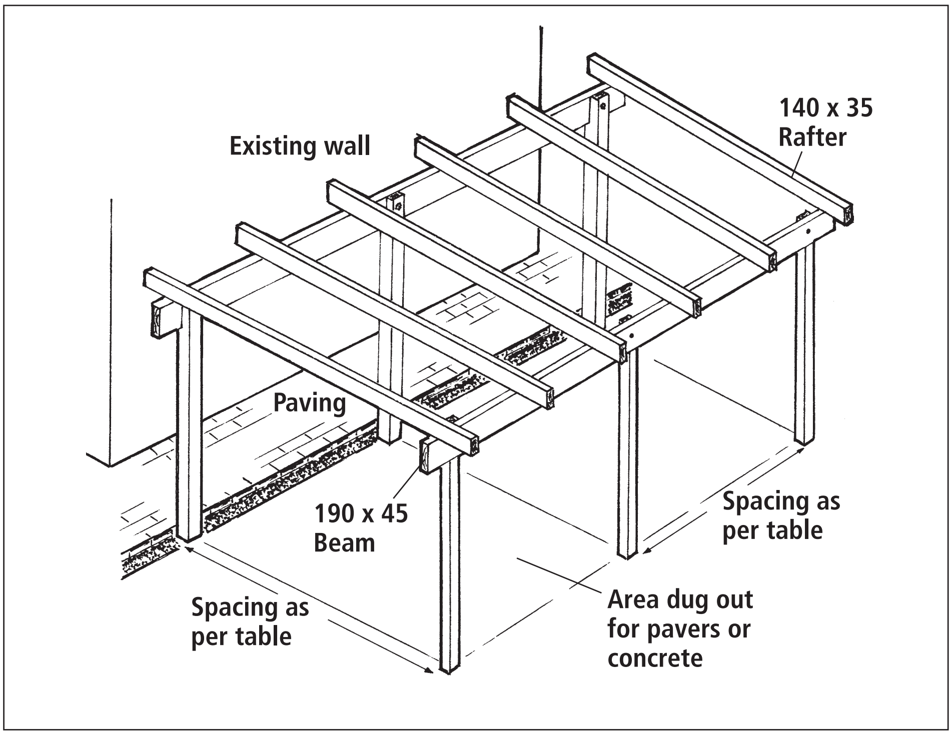


Figure 7.9
Freestanding flat roof shelter.

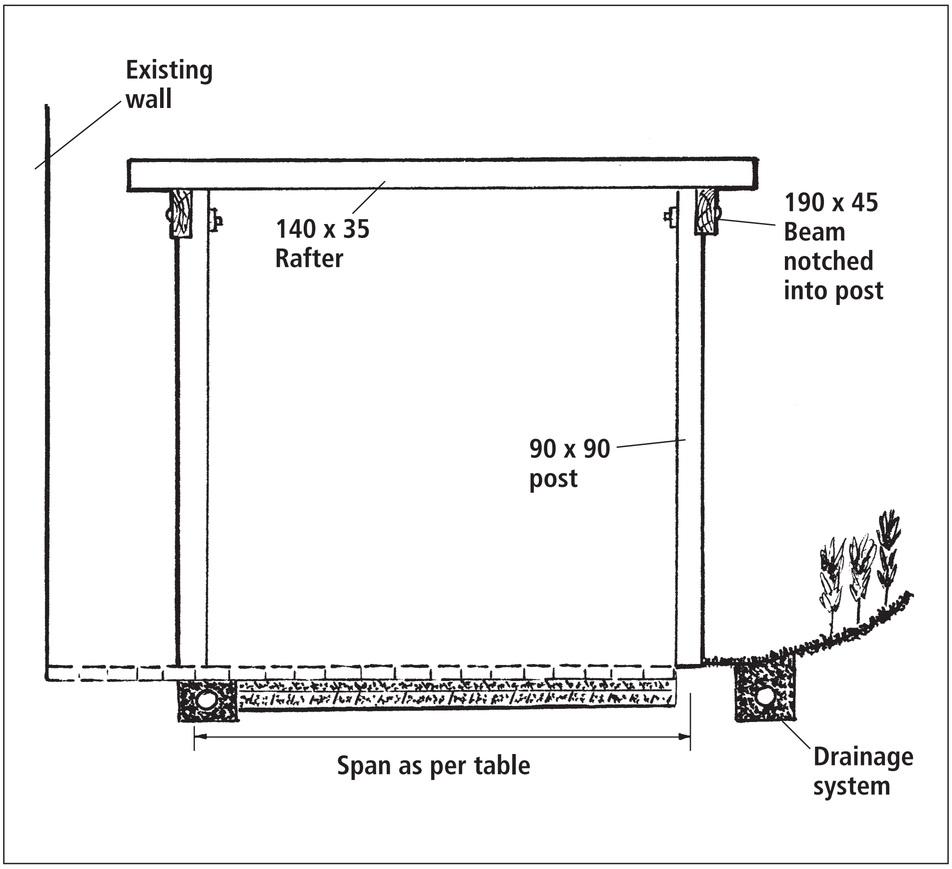


Figure 7.10
Section of freestanding flat roof shelter. (Drawing not to scale.)

Design and construct a freestanding flat roof shelter, or similar structure, using Figures 7.9 and 7.10 as a starting point for your project.

Local building regulations and requirements need to be met. You should refer to Table 2 on page 59 for timber sizes, spans, and spacings.

Detailed working drawings need to be submitted for approval before any construction can begin.

1. First, prepare the site, including consideration of prevailing weather conditions, rainfall, slope and excavations.
2. Then lay out the positions for the posts as required from your working drawing (use the 3–4–5 method to establish true right angles).
3. Dig post holes to a depth of 450 mm using a post-hole digger or a spade.
4. Place a concrete footing at the bottom of each hole. (This can be a preformed concrete block or paver).
5. Measure and cut to length the posts and beams as indicated on your drawing.
6. Mark out and cut notches into the top of each post to position the beams.
7. Clamp the beams in position in each of the notches.
8. Drill 10 mm holes in the beams and posts.
9. Bolt the beams and posts together using 10 mm galvanised cuphead bolts.
10. Stand the posts and beams in the holes and brace for squareness. Be sure to check that each beam is level and that the beams are parallel. (You may need to raise or lower posts to make any adjustments).
11. Cement the posts in position.
12. Mark out the positions for the rafters. Attach the rafters to the beams using either timber anchors such as Trip-L-Lok, or skew nail them.
13. The ends of the rafters can be left square, or shaped as required.
14. Battens may be screwed or nailed to the rafters, or shade cloth may be attached. However, sheet roofing, should not be applied because the roof has no pitch, to allow run off of rainwater.

Activity 2 Attached Flat Roof Shelter

Materials required:
Cement;
Sand and gravel;
Water;
Timber anchors;
Nails;
Galvanised bolts.

Tools required:
Shovel;
Spade;
Post-hole digger;
Electric cement mixer;
Wheelbarrow;
Crowbar;
String line and pegs;
Portable circular saw;
Panel saw;
Cordless drill;
Hammer drill;
Spirit level;
Claw hammer;
G clamps;
Set of spanners;
Try square;
Builders square;
Extension tape;
Pencil;
Bevel square;
Step ladder.

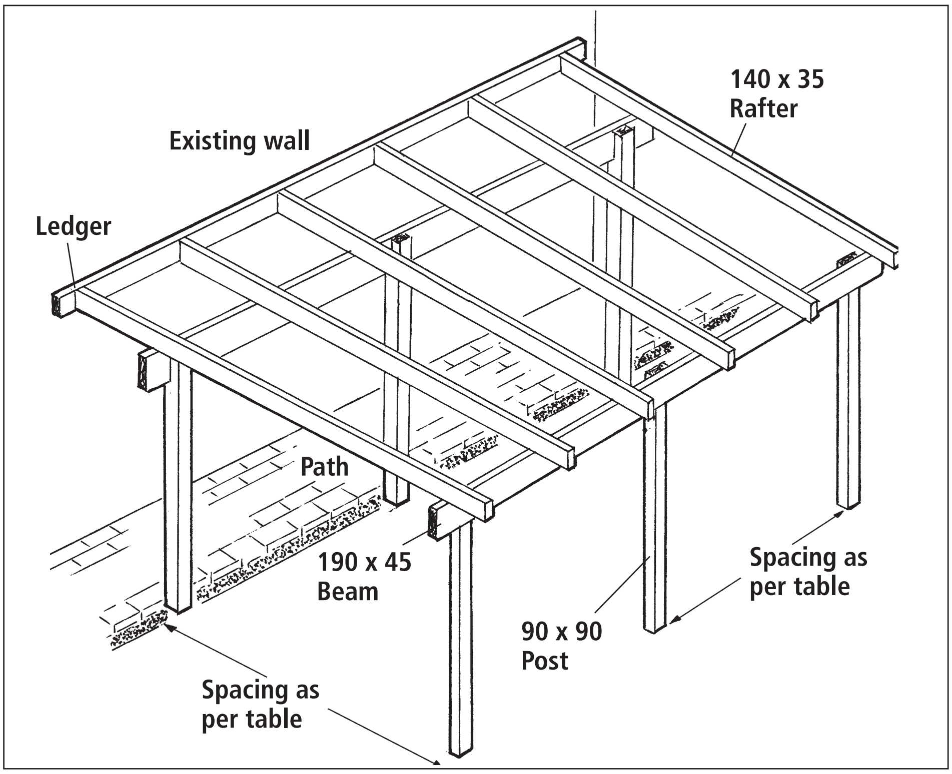


Figure 7.11
Attached flat roof shelter with extra set of posts.

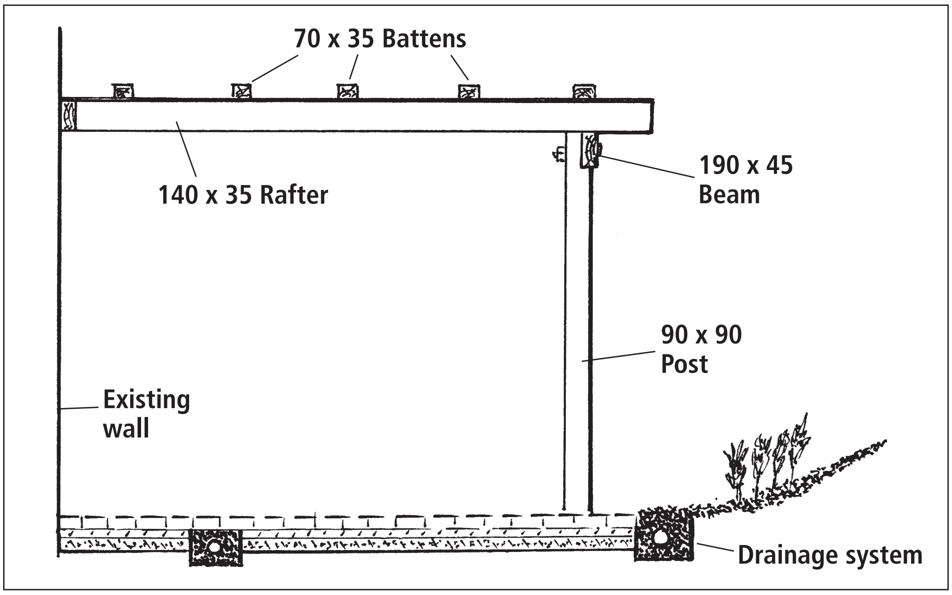


Figure 7.12
Section of attached flat roof shelter with one set of posts.

Design and construct an attached flat roof shelter, or similar structure, using the drawings above as a starting point for your investigation.

Local building regulations and requirements need to be met. You should refer to Table 2 on page 59 for timber sizes, spans, and spacings.

Detailed working drawings need to be submitted for approval before any construction begins.

This structure is similar in design to a freestanding flat roof shelter. The difference is that the rafters are extended and attached to a 'ledger' which has been secured to an existing building. An attached shelter can be built with only one set of posts. The ledger and the building act as the other 'posts' or support. Site preparation and considerations are the same as for freestanding shelters. However, the layout requires only one row of holes to be located.

1. First, prepare the site, including consideration of prevailing weather conditions, rainfall, slope and excavations.
2. Then lay out the positions for the posts as required from your working drawing (use the 3–4–5 method to establish true right angles).
3. Using a post-hole digger or spade, dig the post holes to a depth of 450 mm.
4. Place a concrete footing at the bottom of each hole. (This can be a preformed concrete block or paver).
5. Measure and cut to length the posts and beams as indicated on your drawing.
6. Mark out and cut the notches into the top of each post to position the beams.
7. Clamp the beams in position in each of the notches.
8. Drill 10 mm holes in the beams and posts.
9. Bolt the beams and posts together using 10 mm galvanised cuphead bolts.
10. Stand the posts and beams in the holes and brace for squareness. Be sure to check that each beam is level and that the beams are parallel. (You may need to raise or lower posts to make any adjustments.)
11. Cement the posts in position.
12. Locate the position of the ledger on the existing structure. (The ledger needs to be level with the beam.)
13. Secure the ledger using the appropriate masonary anchor. (These are special fasteners for timber structures.)
14. Mark and cut the rafters to length, and shape the ends.
15. Locate in position on the beam and ledger.
16. Attach the rafters using timber anchors, such as Trip-L-Lok or by skew nailing. The rafter can also be attached to the ledger by stopped housing joints or by resting on a cleat which has been screwed to the ledger. (See Figure 7.13, page 69.)
17. Battens may be screwed or nailed to the rafters for securing shade cloth, or for an attractive appearance. However, sheet roofing material should not be applied because the roof has no pitch.

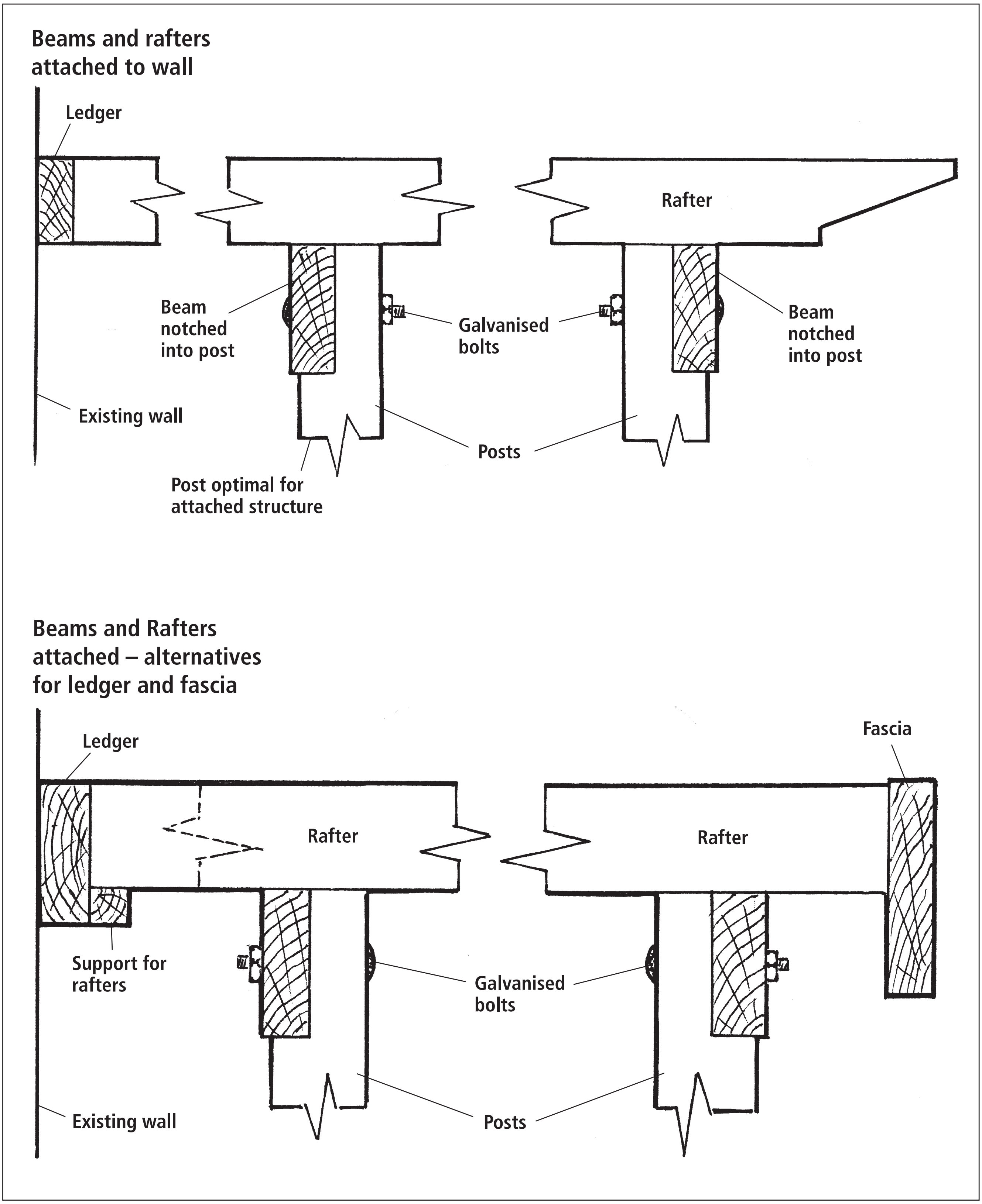


Figure 7.13
Attaching beams and rafters to existing structure.

Activity 3 Freestanding Or Attached Pitched Roof Carport

Materials required:
Cement;
Sand and gravel;
Water;
Timber anchors;
Nails;
Galvanised bolts.

Tools required:
Shovel;
Spade;
Post-hole digger;
Electric cement mixer;
Wheelbarrow;
Crowbar;
String line and pegs;
Portable circular saw;
Panel saw;
Cordless drill;
Hammer drill;
Spirit level;
Claw hammer;
G clamps;
Set of spanners;
Try square;
Builders square;
Extension tape;
Pencil;
Bevel square;
Step ladder.

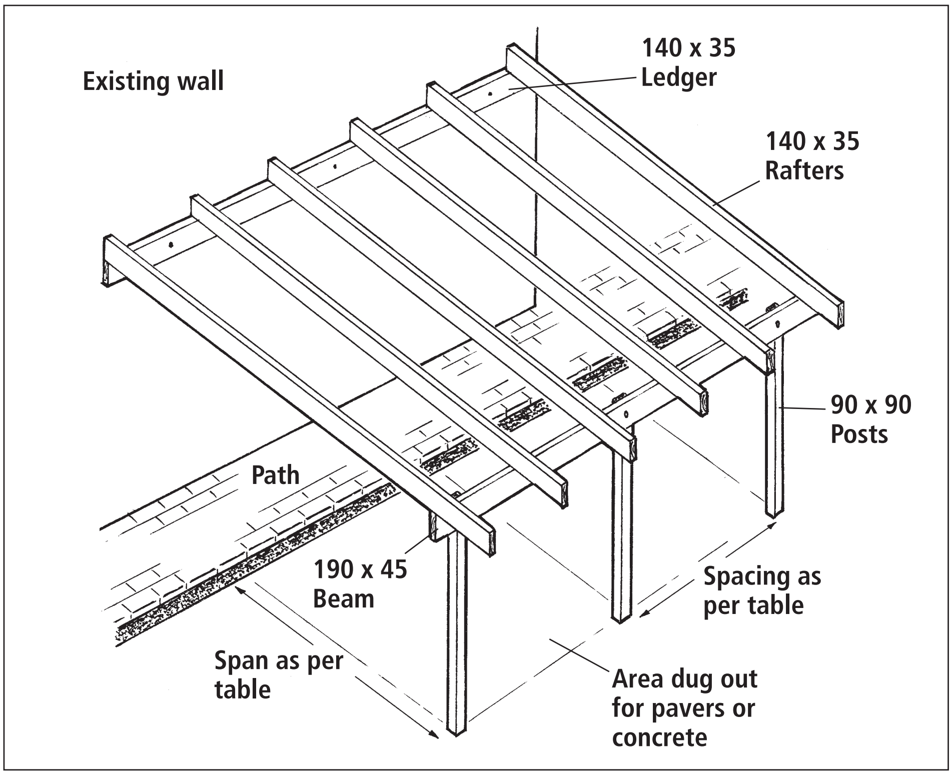


Figure 7.14
Attached pitched roof carport.

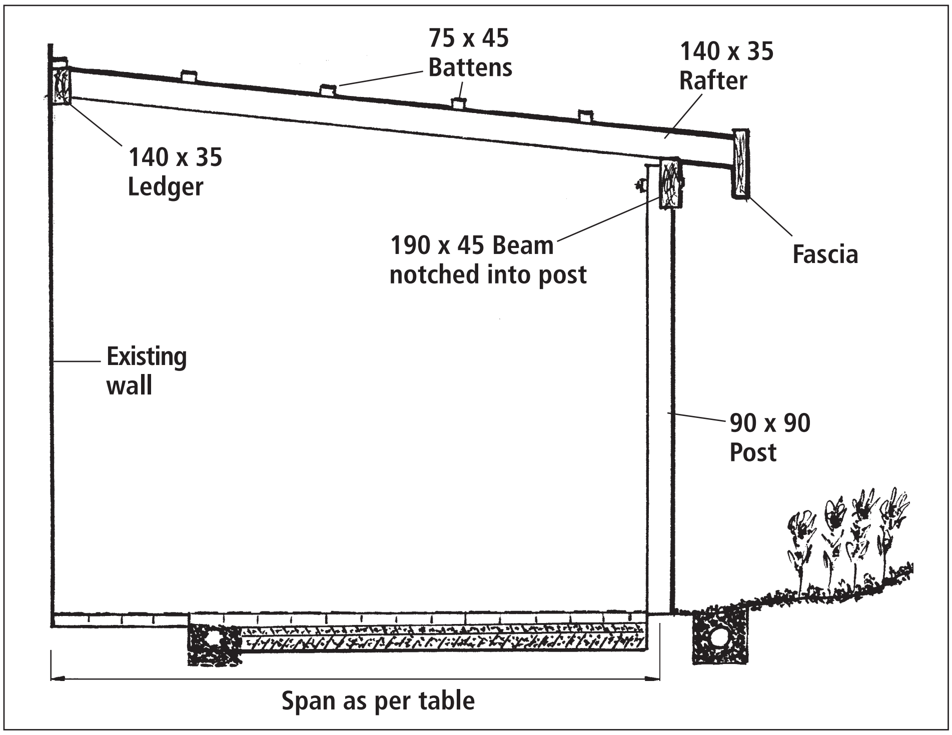


Figure 7.15
Section of attached pitched roof carport.

Design and construct a freestanding or attached, pitched roof carport, or similar structure. Use the drawings on this page as a starting point for your investigation.

Local building regulations and requirements need to be met. You must refer to Table 2 on page 59 for timber sizes, spans, and spacings.

Detailed working drawings need to be submitted for approval before any construction can begin.

This structure can be either freestanding or attached to another building.

The pitched roof provides a slope that allows for water run off. It can also help with ventilation.

To provide this 'pitch' in either a freestanding or an attached carport, one of the sides needs to be higher than the other (generally by 5°).

Site preparation and details are the same as those specified for freestanding and attached flat roof shelters.

1. First, prepare the site, including consideration of prevailing weather conditions, rainfall, slope and excavations.
2. Then lay out the positions for the posts as required from your working drawing (use the 3–4–5 method to establish right angles).
3. Using a post-hole digger or a spade, dig the post holes to a depth of 450 mm.
4. Place a concrete footing at the bottom of each hole. (This can be a preformed concrete block or paver).
5. Measure and cut to length the posts and beams as indicated on your drawing.
6. Mark out and cut the notches into the top of each post to position the beams.
7. Clamp the beams in position in each of the notches.
8. Drill 10 mm holes in the beams.
9. Bolt the beams and posts together using 10 mm galvanised cuphead bolts.
10. Stand the posts and beams in the holes and brace for squareness. Be sure to check that each beam is level and that the beams are parallel. (You may need to raise or lower posts to make any adjustments.)
11. Cement the posts in position
12. Locate the position of the ledger on the existing structure. For an attached pitched roof carport or shelter, locate the ledger on the existing structure, slightly higher than the opposite beam to give a slope over the width of the carport or shelter of at least 5°.

Note
For a freestanding pitched roof structure, stand the other row of posts and beams in the holes. Raise the second lot of posts slightly higher than the opposite row to give a slope of at least 5° over the width of the carport or shelter.

13. Secure the ledger to the wall using the appropriate masonry anchors. (These are special fasteners for timber structures.)
14. Mark and cut the rafters to length, and shape the ends.
15. Locate in position on the beam and ledger.
16. Attach the rafters using timber anchors, such as Trip-L-Lok or by skew nailing. The rafter can also be attached to the ledger by stopped housing joints or by resting on a cleat which has been screwed to the ledger. (See Figure 7.13, page 69.)
17. Screw or nail the battens to the rafters, at 900 mm centres to allow for sheet roofing material to be applied.

Activity 4 Freestanding Or Attached Gable Roof Carport

Materials required:
Cement;
Sand and gravel;
Water;
Timber anchors;
Nails;
Galvanised bolts.

Tools required:
Shovel and spade;
Post-hole digger;
Electric cement mixer;
Wheelbarrow;
Crowbar;
String line and pegs;
Portable circular saw;
Panel saw;
Cordless drill;
Hammer drill;
Spirit level;
Claw hammer;
G clamps;
Set of spanners;
Try square;
Builders square;
Extension tape;
Pencil;
Bevel square;
Step ladder.

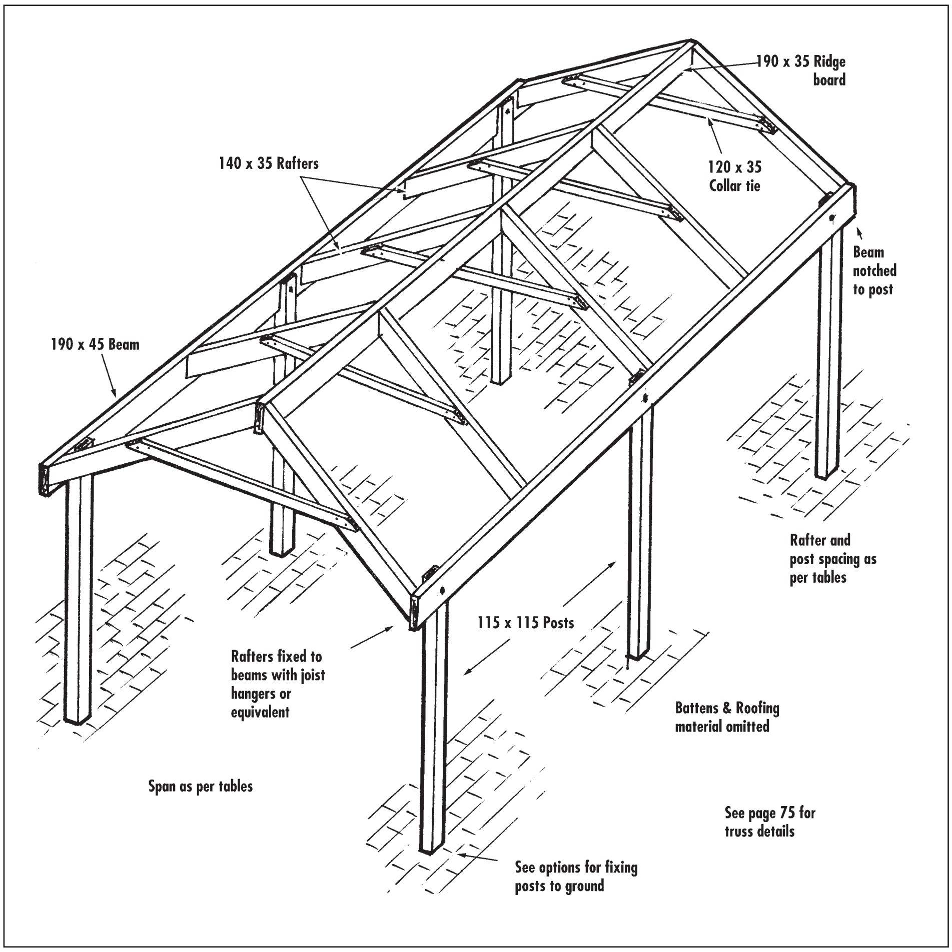


Figure 7.16
Freestanding gable roof carport.

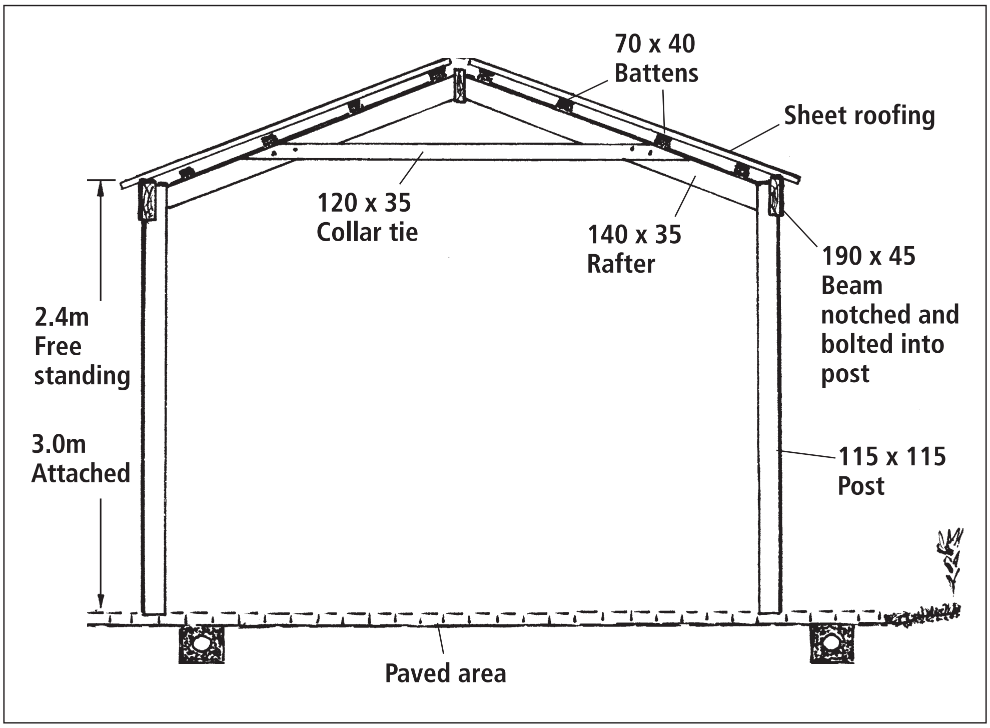


Figure 7.17
Section of a freestanding gable roof carport.

Design and construct a gable roof carport, or similar structure. Use Figures 7.16 and 7.17 as a starting point for your project.

Local building regulations and requirements need to be met. You must refer to Table 2 on page 59 for timber sizes, spans, and spacings.

Detailed working drawings need to be submitted for approval before any construction can begin.

This structure can be freestanding, as shown, or attached to another building. The common pitch for a gable roof is 22.5°.

The site considerations and excavations are the same as for freestanding or attached shelters.

Follow the steps for setting posts and beams in position which are set out in Activities 2, 3 and 4.

i. e. Peg out the positions for the post holes as per dimensions on your working drawing using the 3–4–5 method. Using a post-hole digger or spade, dig the holes 450 mm deep and pour a suitable concrete footing in the holes. Measure and cut the posts, including the notching, to the required size and clamp the beam(s) in place.

With a 10 mm drill, bore holes through the beam and posts and bolt together with 10 mm bolts.

Slide the posts and beams into the holes, brace for squareness and cement in place after checking the beams are level.

Where the carport is attached to another building or fascia, a single row of posts and beam is levelled with the existing fascia or ledger.

Constructing The Gable Roof

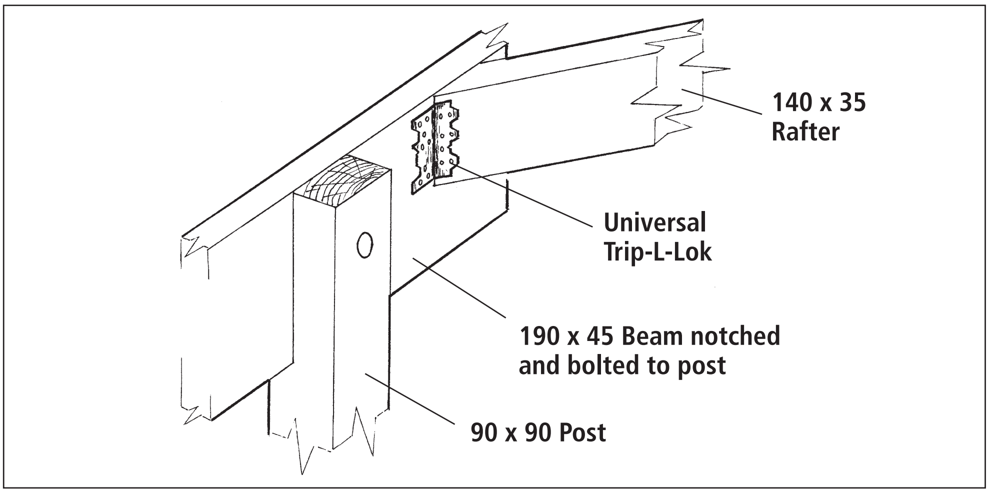


Figure 7.18
Attaching rafter beam for a gable roof.

1. Mark out and cut the rafters to the correct length and angles which are appropriate for a nail plate or ridge board.
2. Hold the end rafters temporarily in position with collar ties clamped to them. Secure the end rafters in position, with Trip-L-Grip or universal-grip timber anchors nailed to the side beams on each side.
3. Repeat this process for each of the intermediate rafters.
4. If a ridge board is being used, position this in place and skew nail it through the rafter.
5. Drill and bolt collar ties in position.
6. If a nail-on-plate is being used, each rafter assembly can be fixed together on the ground (including the collar tie). Then each whole rafter assembly can be positioned independently using braces to temporarily hold them in position.

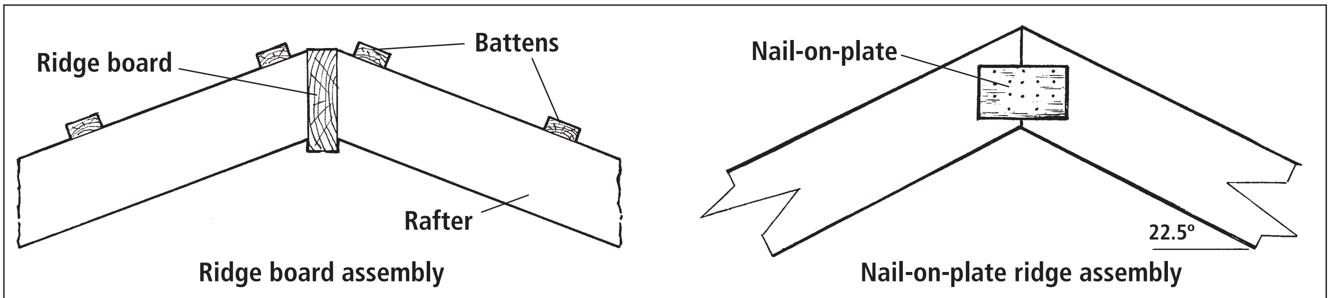


Figure 7.19
Ridge assembly.

7. When all the rafters are in position, check them for squareness and that they are parallel.
8. Nail the battens in position.
9. Attach sheet roof material in place, or attach appropriate shade cloth using shade cloth fasteners.

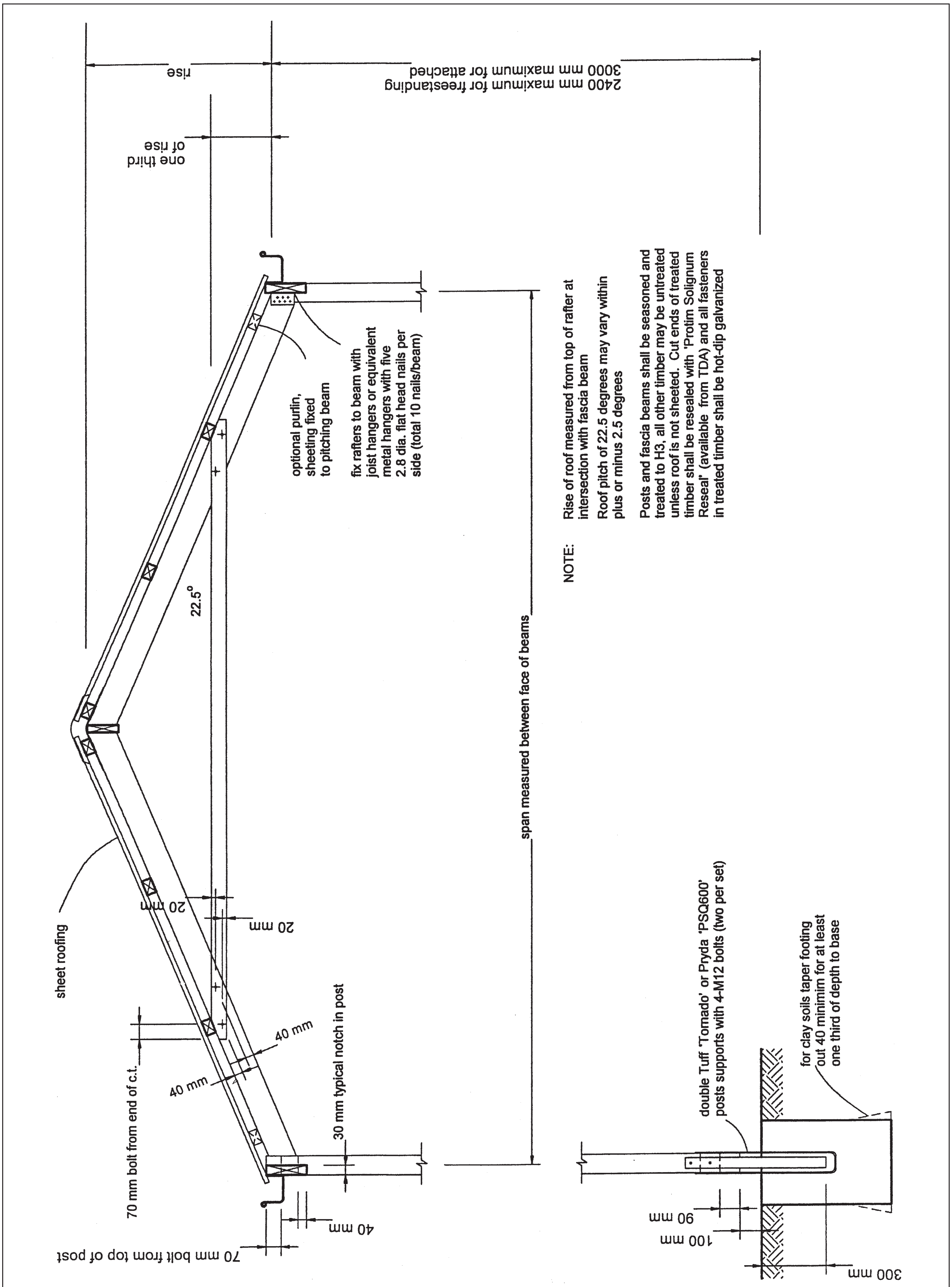


Figure 7.20
Footing and roof framing for freestanding structures.

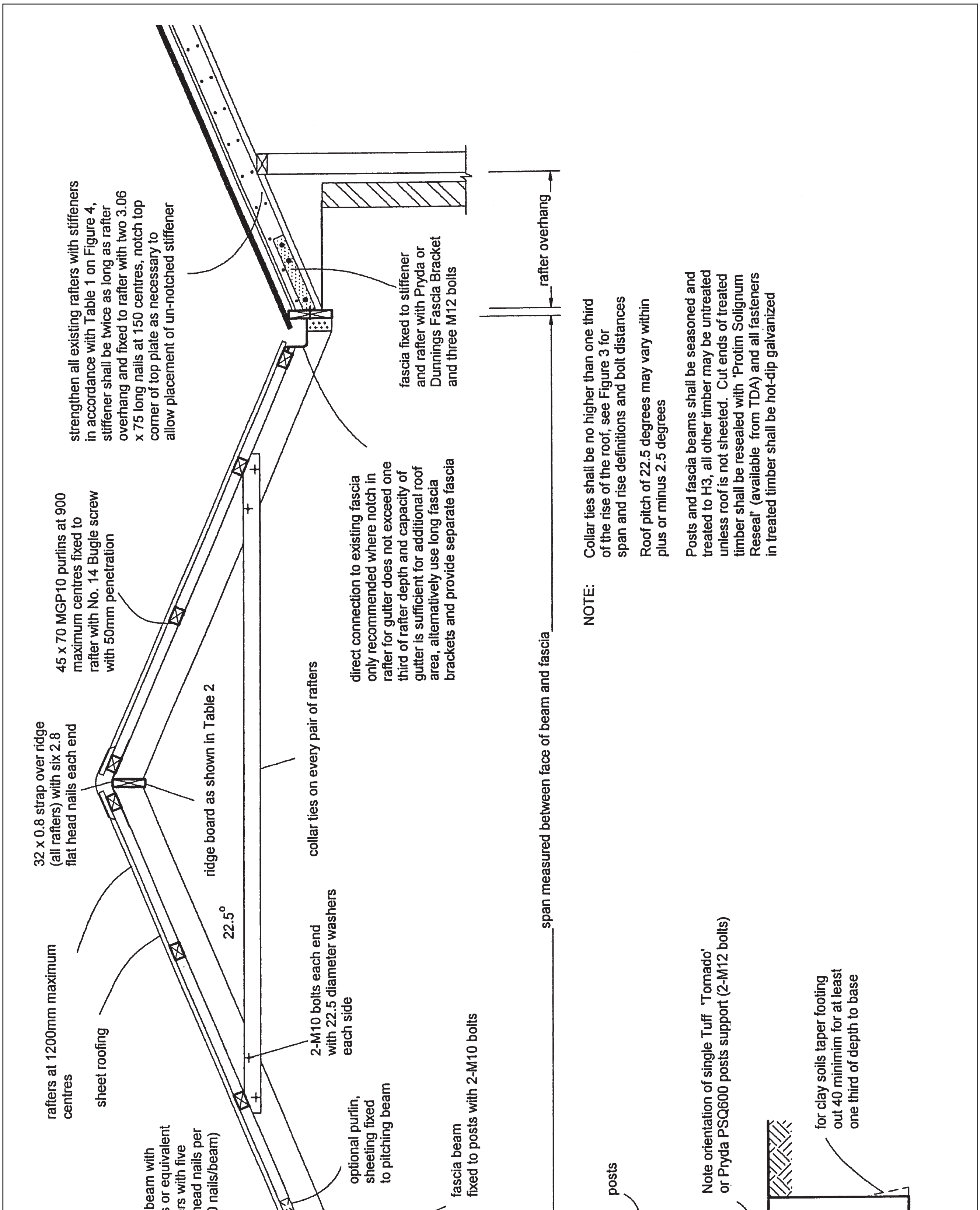


Figure 7.21

Footing and roof framing for attached structures.

Metric and Imperial Conversion

For ease of calculation 25 mm is assumed to equal 1 inch

Increments of 1 mm

Millimetres	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Millimetres
Inches	0		$\frac{1}{8}$				$\frac{1}{4}$						$\frac{1}{2}$				$\frac{5}{8}$				$\frac{3}{4}$		$\frac{7}{8}$			1	Inches

Increments of 25 mm

Millimetres	0	25	50	75	100	125	150	175	200	225	250	275	300	Millimetres
Inches	0	1	2	3	4	5	6	7	8	9	10	11	12	Inches

Increments of 300 mm

Metres	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.8	Metres
Millimetres	300	600	900	1200	1500	1800	2100	2400	2700	3000	3300	3600	3900	4200	4500	4800	Millimetres
Inches	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	Inches
Feet	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	Feet

Unit 8: LAYING CONCRETE FLOORS

Objectives

By the end of this unit you should be able to:

- Lay out and prepare a suitable site.
- Box-up formwork ready for concreting, including reinforcement mesh.
- Calculate the volumes of materials required and place an order.
- Correctly mix the concrete and wheelbarrow it to the site.
- Level concrete using a straight edge or 'screed'.
- Use a wooden float to finish a concrete surface.
- Use high density foam to produce an attractive surface finish.

Concrete is a most versatile material. It may have a plain, smooth surface or a rough textured pattern depending on requirements. These extremes are possible because concrete is a plastic material able to take almost any form. It can be finished in a wide variety of surface finishes.

Concrete Formula

Concrete is a mixture of gravel, sand, cement and water and its characteristics are determined by the proportions of these ingredients. The formula suggested for patio floors is four parts gravel, three parts sand and one part cement (4:3:1). The water should be clean. Add the water in small quantities when you are mixing the concrete, until the desired consistency is achieved.

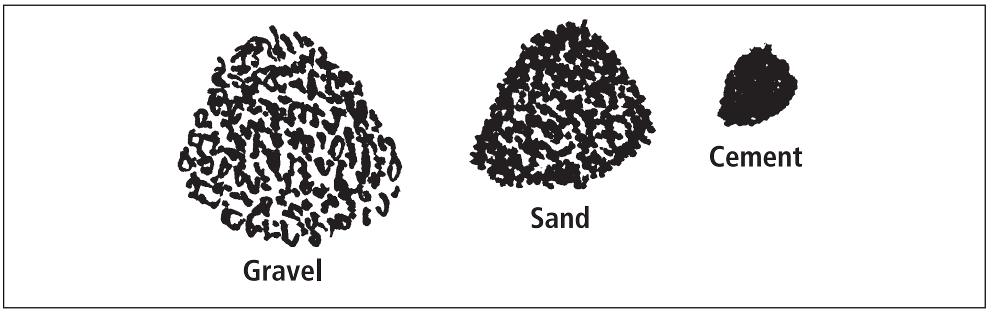


Figure 8.1
Concrete formula.

Site Preparation

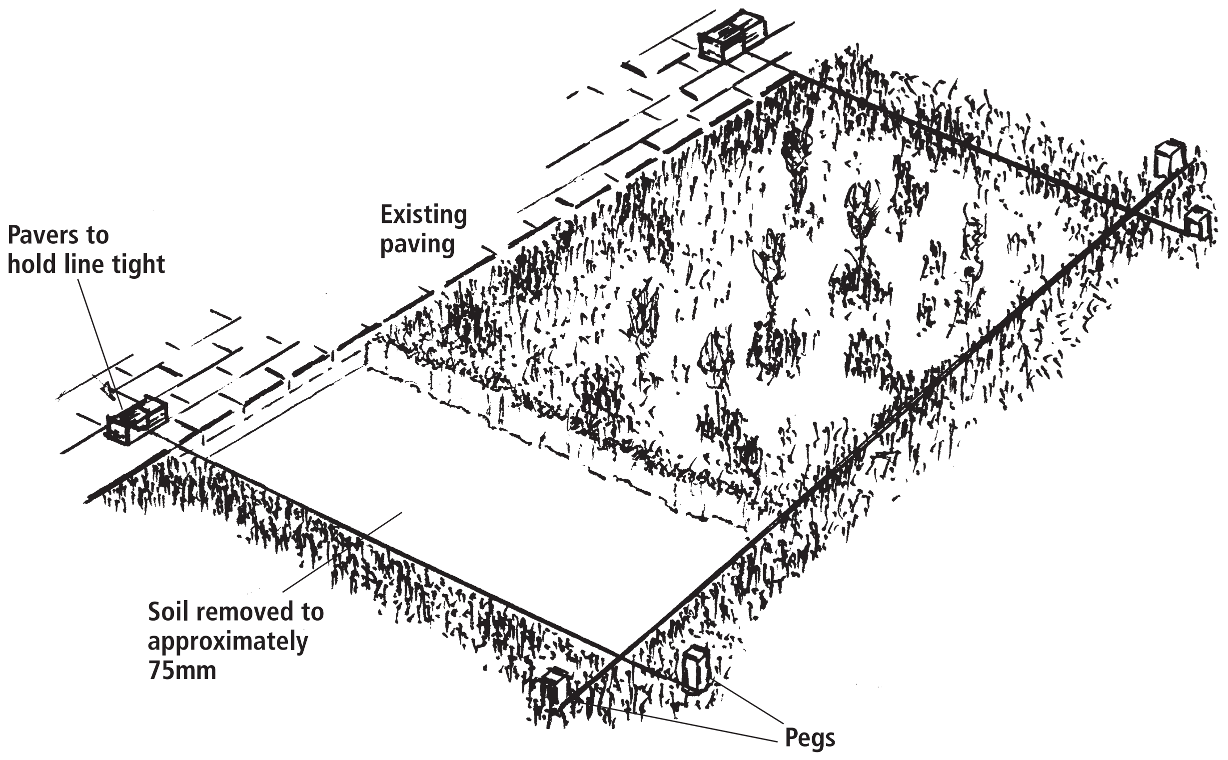


Figure 8.2
Site preparation.

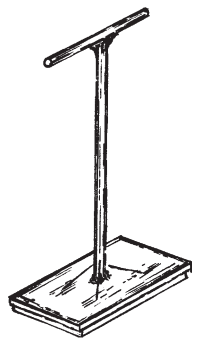


Figure 8.3
Tamping tool.

Using the 3–4–5 method, wooden or steel pegs, and a string line, measure and lay out the area to be concreted (Figure 8.2). This area should be levelled to approximately 75 mm below the level where you want the finished concrete to be. It may be necessary to 'dig out' the area with a pick and shovel. Or, you may need to backfill areas, which are already more than 75 mm deep. (Be sure to compact back-fill areas by tamping down thoroughly).

A thin layer of sand (25 mm) can be evenly spread over the area to provide a more level base. To assist in the 'boxing up' stage, prepare the area to between 50 and 70 mm past each of the string lines.

Boxing Up

Boxing up requires straight and parallel timbers called formers. They are of approximately 75 × 20 mm dimensions. Steel pegs, a hammer and a spirit level are also required.

Where the concrete floor is to be laid against an existing path or similar structure, the path edge may be used as one side or 'former'.

Measure the width of the concrete floor and locate the 'length' former in position using steel pegs as shown in Figure 8.4. Cut the required number of width 'formers' to fit neatly between the existing path and the length former.

The width formers are placed at a distance apart that you can easily reach using a trowel. (This will be between two and three metres).

Locate the two end width formers in position using the 3–4–5 method and support with steel pegs. See Figure 8.4.

Measure the appropriate distances for the intermediate width formers and fix them in position. Using a spirit level, adjust the height of the formers to make sure that there will be sufficient 'fall' or slope on the finished concrete floor.

To provide extra strength and stability, include 150 × 150 × 6 mm reinforcing mesh in each of the sections of concrete.

Note
The mesh is supported on small bricks or flat stones to ensure it finishes in the middle of the layer of concrete. The mesh should not be on the ground.

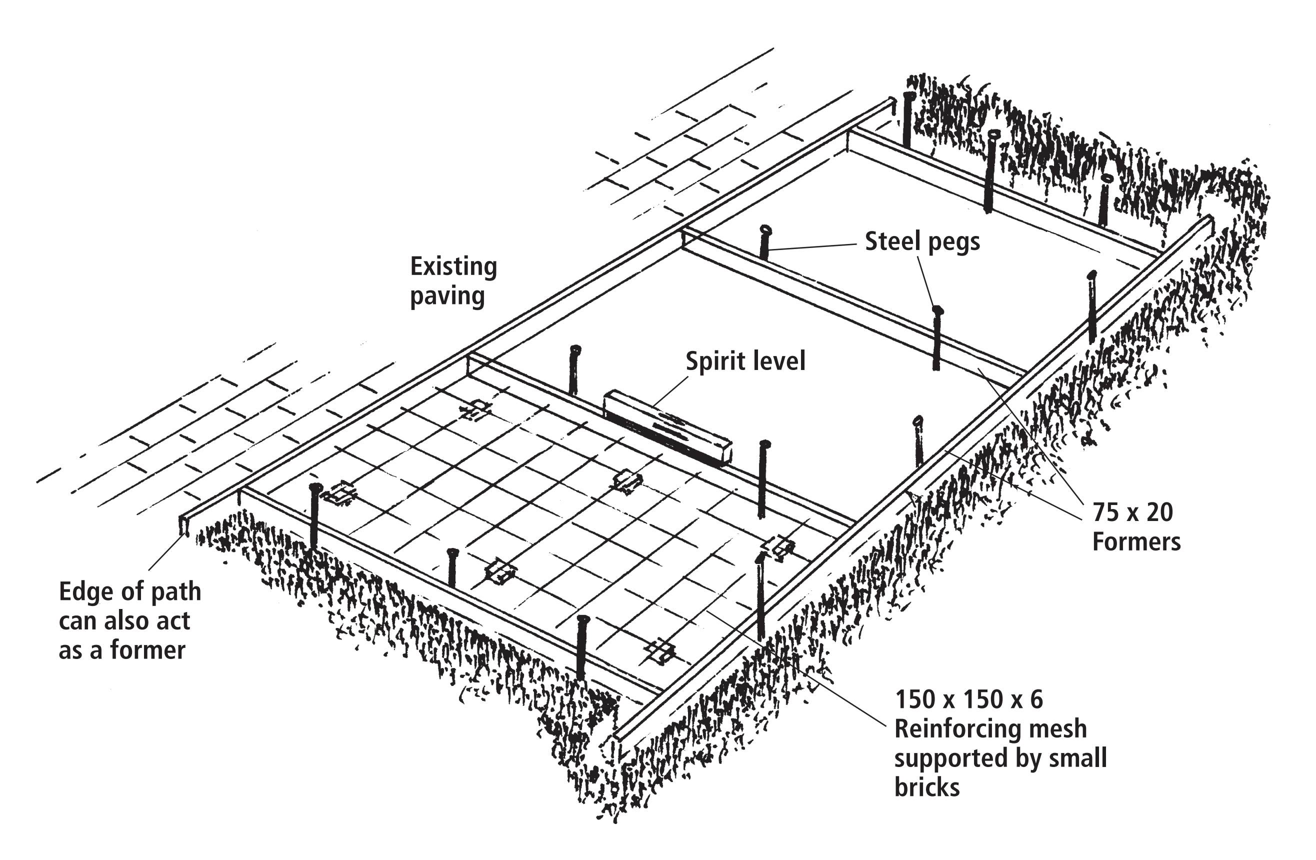


Figure 8.4
Boxing up.

Mixing Concrete

When mixing concrete the ratio of water to cement is important. Concrete hardens because the powder-like cement and water form an adhesive. This adhesive bonds the sand and gravel together:

Too much water dilutes this adhesion and weakens the cementing qualities.

Too little water increases the cementing qualities, and the cement is very difficult to work.

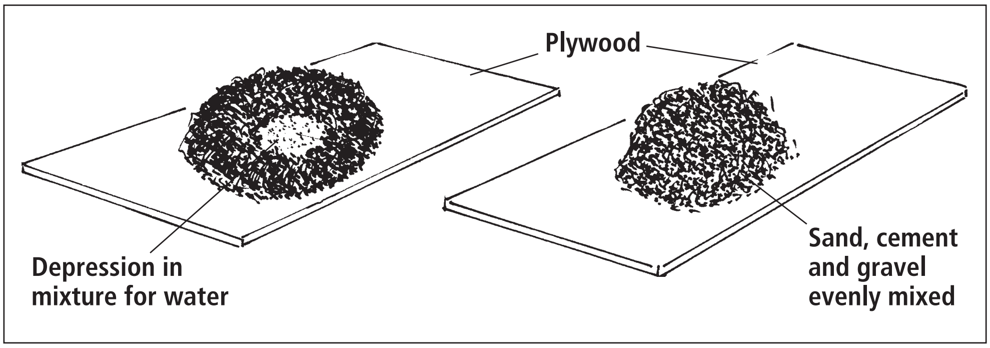


Figure 8.5
Mixing concrete.

If you are mixing small quantities, you can mix it on a sheet of plywood, or in a wheelbarrow.

Step 1 Measure the quantity of sand and cement and place them in a heap.

Step 2 Turn and mix the dry ingredients with a shovel or spade until there are no streaks of colour.

Step 3 Add the gravel, and mix until the stones are evenly distributed throughout the mixture.

Step 4 Make a depression like a bowl in the centre of mixture.

Step 5 Slowly add some water into the depression and turn the ingredients until they are thoroughly combined.

Step 6 Repeat steps 4 and 5 until the concrete mixture is the correct consistency.

Step 7 For larger quantities, use the same procedure, but with an electric or petrol driven cement mixer.

Screeding Concrete

If you are working large areas, it is easiest to 'box' them into smaller compartments, or bays. This provides manageable areas. You can complete all the areas at the same time, or you can do them individually over a period of time.

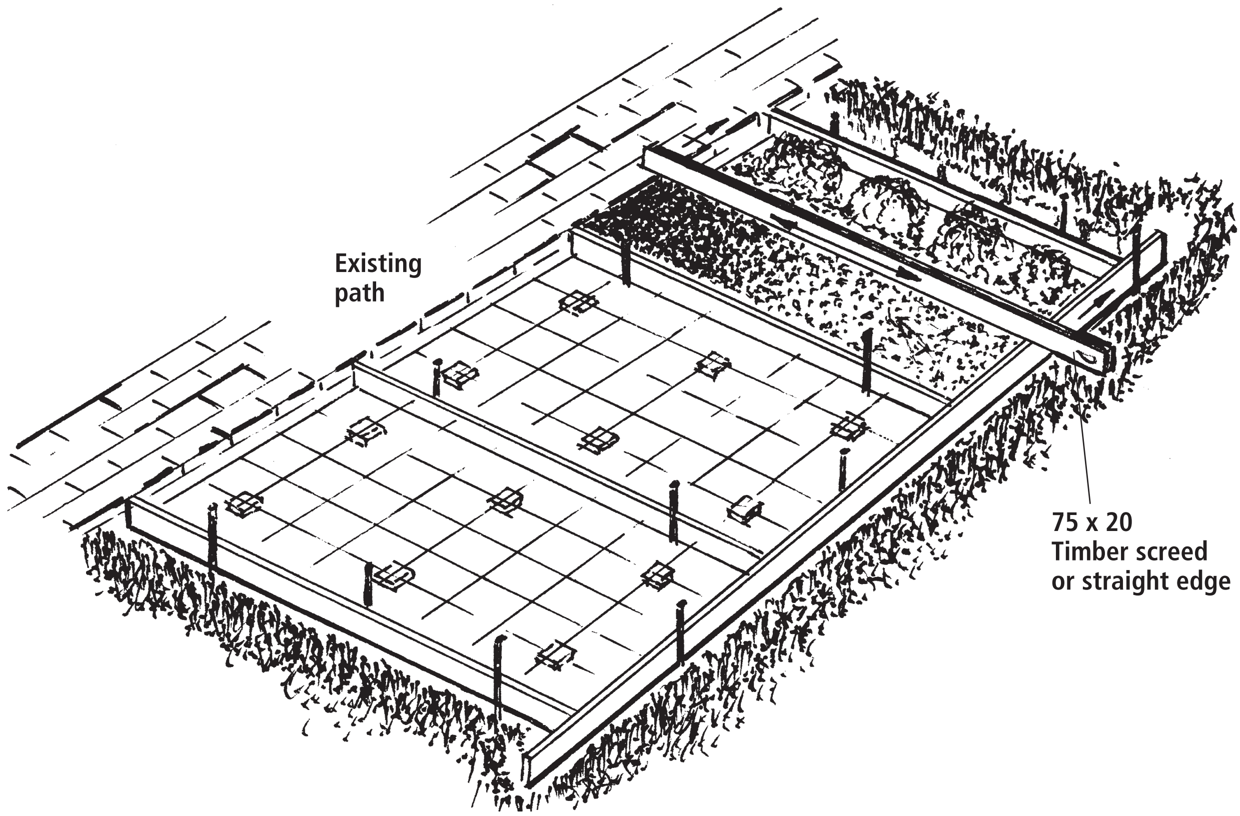


Figure 8.6
Screeding concrete.

Step 1 Fill a wheelbarrow with the concrete you have prepared.

Step 2 Fill in one compartment with concrete.

Step 3 Level it with a shovel as you put in the concrete.

Step 4 When the compartment is filled, use a timber 'screed board' or straight edge (75 × 20 mm) to finally level and compact the concrete.

The 'screed' is more easily used by two people, one either side of the concrete. Each person pulls back and forth on the screed. You move along from one end to the other of the concrete, while resting the screed on the path and the former (Figure 8.6).

Step 5 This process is repeated for each of the remaining compartments. The steel pegs and width formers are removed as you move along to the next section.

Surface Finishing

When you use the screed board, or straight edge, the continuous back and forth movement will bring water to the surface, and the 'tamping down' will help push the gravel down below the surface.

It is due to this excess surface water, that time is required to allow the cement to partially 'go off' or set, before you apply any surface treatment. When the surface moisture has disappeared, the concrete has a 'dull' appearance. At this point, you can move a wooden float in large sweeping arcs, to remove any ridges that the screed board may have left.

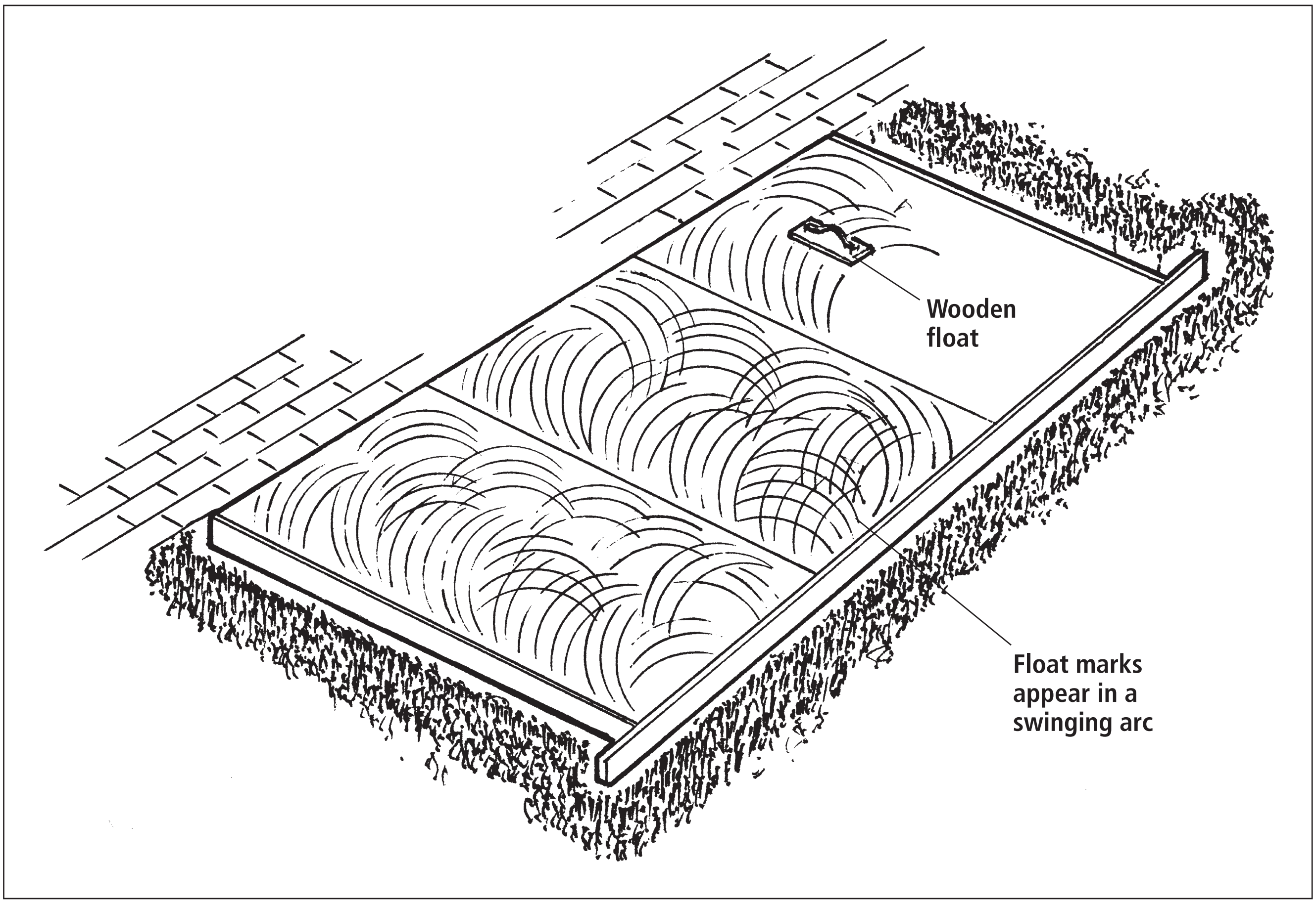


Figure 8.7
Floating surface.

At this time, you can use an edging tool to form a recess and curve on the outside edge of the floor. You may also use a grooving tool to form a recess and groove indicating each 'compartment'.

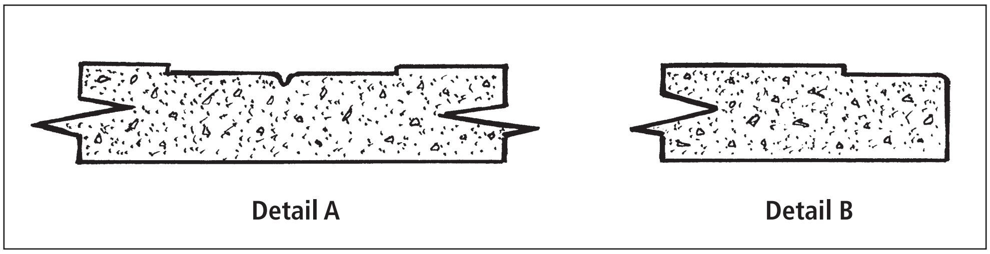


Figure 8.8
Grooving profile.

The edging tool is used by holding it at a slight angle and tightly against the edges of the formers. The grooving tool is used by laying the 'screed' or straight edge flat on the surface where the width formers were. It can then be used as a guide for the grooving tool to move against.

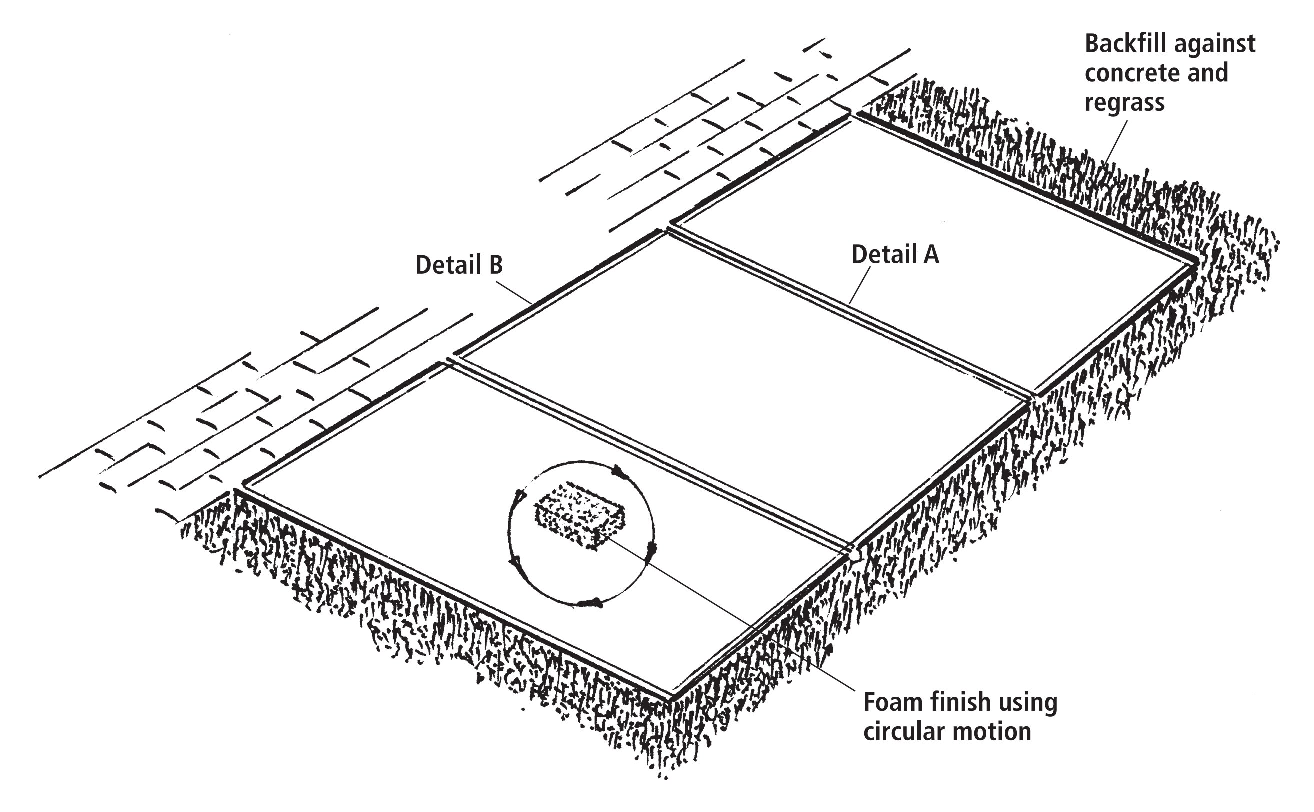


Figure 8.9
Foam finishing.

The finish obtained from a wooden float is quite rough, although it will be flat and level. To obtain a 'smoother' surface, which is still textured and non slip, move a small piece (200 × 150 mm) of damp high density foam in small circular movements over the surface. This will produce an attractive surface finish. If an extra smooth surface finish is desired a steel float is used.

Reviewing the Design Process

Context

Building construction

Design Brief

Task: Design and construct a freestanding shelter on a given site

Constraints: Shelter to have a concrete floor
Timber frame construction to include posts, rafters, battens
Roof to be made of suitable sheet material
Provision for sun and rain protection on sides

Investigation

Design Brief:
- Possible designs
- Suitable materials
- Construction methods
- Site requirements
- Equipment required
- Costs involved

Resources:
- Pamphlets, reference books, photographs of existing similar structures, local building regulations

Designing

Site Preparation:
- Levelling
- Drainage

Design Structure:
- Details — (Drawing)

Building Methods:
- Posts — in ground
- Rafters, battens
- Roof material

Producing

- Securing posts in ground
- Securing rafters to fascias
- Attaching battens to rafters
- Securing roof material to battens
- Boxing up for concrete
- Pouring concrete and finishing

Evaluation

- Has the design brief been met?
- Were there problems arising during the process?
- What would you do differently in your next investigation?

Key vocabulary for Year 11 Design and Technology

Vocabulary	Useful words that go with the key word	Other words
absorb	low water absorption	absorption
accessible		
accurate	an accurate saw cut, accurate measurements, accurately measured	accurately
activity	agricultural activities	
actual	the actual length	
adjust	easily adjusted	adjustable,non-adjustable, adjustments
advantage	one advantage of…	disadvantage
agricultural		
angle	at all angles, a low angle, an angle of 30°	
appropriate	the appropriate tool for…	appropriately
attach		
automatic		automatically
available	a range of sizes is available	
avoid	avoid unintentional starting	
base	the base of the machine	
broad	a broad base	
characteristic	the characteristics of natural timber	
chemical	fire proofing chemicals	
classify	the glue is classified as permanent	classification
commercial		
condition	exterior conditions	
connect	connect the machine to the power	disconnect
construct		construction
contact	in contact with, in close contact	
convenient	it is convenient to…, a convenient tool	
defect	free from defects	
density	high density	
depend on		
design	it is designed for use outdoors, design process	
detail		detailed
development	site development	
dimension	the overall dimensions	dimensioned
effectively		
enable		
enlarge		enlarged
equivalent		
essential	it is essential to, an essential step	
even	even thickness, evenly spread	evenly
exterior		
factor		
firm	firmly clamped	firmly
flexible		flexibility
function		
guide	guide the saw	
horizontal	horizontal lines	
identify		
illustration		
improve		
include		
industrial	industrial uses	
insert		

Vocabulary	Useful words that go with the key word	Other words
inspect		inspection
interior		
internal	the internal surface	
layer	thin layers of wood	
level	to level the ground	
location		
maintain	maintain tools, maintain a parallel line	
manufacture	manufacture furniture	
maximum		
mechanism		
moisture		
numerous	numerous types and sizes	
occur		
outer	the outer wall	
parallel	parallel to the edge	
particularly	particularly important	
permanent	a permanent adhesive	
pressure	apply slight pressure	
prevent		
production	the production process	
properties	timber properties, desirable properties	
protective	protective clothing	
quality		
range	sizes range from 150 mm to 300 mm in length	
ratio	strength to weight ratio	
reading	a level reading	
recognise		
reduce	a reduction scale	reduction
relationship		
remove		
require		
resistant	moisture resistant	resistance
result	result in accidents	
securely	attach the string securely	
similar	similar to wood, in a similar way	
site	a building site, site preparation	
species		
specify	specified thickness	specification
spread	spread the glue, its use is widespread	widespread
standard	standard sizes	
structure	an outdoor structure	structural
sufficient	sufficiently accurate	sufficiently
suitable		suitable for painting
support		
switch	the switch is off	
technical	technical drawings	
transfer		
uniform		uniform thickness
unlikely		
variety		
vary	a varying number, a variable speed	variable
vertical		
visible	the visible outline	

Related to hand tools
a post-hole digger, a petrol cement mixer, an electric cement mixer, concrete, to compact soil, tamp, spring loaded, a peg, true, true vertical, true horizontal, bevel, bevelled, a blade, a rivet, a clamp, a vice, a chisel, a plane, board, hardwood, sheet material, veneer, a crosscut saw, a panel saw, to rip, grain, in the same plane, fill, dolomite, a paver, a joint, a trestle, cut to size, a deck

Related to materials
particle board, MDF – medium density fibreboard, hardboard, crossband, the figure (of the grain), clip to size, moisture content, a panel, the core, shrinkage, synthetic resins, splice, cure electrically, pressing, cold press, hot press, pre-press, sand, sanding, drum sander, grading, a check, an adhesive, a bond, marine, structural, formwork, stress, long term stress, durability, eucalypt, pine, a fibre, thermo set, heat set, an insecticide, a fungicide, fire-retardant, dimensional stability, cladding, acoustic, thermal, polyurethane, polystyrene, a preservative, air-borne, water-borne, oil-borne, CCA (copper, chrome, arsenic), water repellent

Related to building designing and constucting
erosion, trenches, drains, backfill, gravel

Related to drawing and design
a scale, architectural conventions, timber, freestanding, a post, a post anchor, a beam, a rafter, a batten, framing, footing, a gable roof, a roof truss, a span, a pitch, a joist hanger, a ledger, galvanised, to secure, to fix

Related to portable power tools
cordless, an extension cord, indoor, outdoor, roofing, flooring, specifications, a profile, a rebate, chamfer, a groove, softwood, freehand, saw horses, accessories, a fine finish, a smooth finish, a knot, sound timber, double insulated, reversible, a chuck, heavy duty, torque, a gearbox, tungsten carbide, masonry, marble, tiles, sheet metal, fibreglass, plywood, orbital, lubricant

Related to laying concrete
boxing

Related to building terminology
a joist, a fascia, plumbing, a slab, embed, brackets, a member, a bearer, a joist strap, skew nailing, a cross section, dressed timber, guttering, a stud, a plate, skirting, noggings, bracing, compression, tension, patented fasteners, a gauge, non-ferrous

Useful structures for Year 11 Design and Technology

Describing use
String lines **are used to** mark out areas of a building site.
The claw hammer **is used to** drive in or remove larger nails.
Generally the panel saw **is used for** finer work.
They **are used for** light work such as cutting thin sheet materials.
These are the boards that **are** generally **used for** wall and ceiling linings.
For example, a string line is **useful to** show the position of a frame.
It is most **useful for** laying out the angles when cutting the rafters for a gable roof.

Passive language
Only the dimensions which are necessary for carrying out the work **should be shown**.
For a fine finish, the planer **should be moved** more slowly over the work.
The timber **must be** well **supported**.
This increases the types of work that **may be done** with a drill.
Portable saws **are** also **equipped** with spring loaded guards for the blade. These guards **must be maintained** in good order so that they operate correctly.
They **are designed** to drill bricks, stone, and other masonry materials.

Expressing possibility
The vials **may** be adjustable or non-adjustable, and may contain 'proved' or 'ground' glasses.
The safest method is to use a fence to guide the machine, but the saw **may** be used freehand.
The press platens **may** be heated with steam, hot water or oil.
Other chemicals, such as insecticides, fungicides and fire-retardants, **can** also be added to provide specific protection.
Bevel cuts are also **possible** by tilting the machine on its base.
It is **often** useful to drill a small hole at the other end to accommodate a pencil.
Good quality machines have a tilting base for cutting angles, and **often** have a variable speed control from 0 to 3200 strokes per minute.
Splintering is **likely** to occur in thin wood materials, particularly plywood.

Expressing caution or warning
You **must be careful when** you use a plumb bob that both the string line and the plumb bob are able to swing freely.
The veneer edges **must be** made square and straight **so** they may be joined with the least visible joint line.
It is **essential that** the rivets, which attach zero hooks on tape rules, are not fixed.
When you are laying pavers it is **essential that** the soil fill is packed down to give a firm surface.
This is **particularly important when** you are cutting veneered manufactured boards **because** the veneer layer is extremely brittle, and breaks easily with rough edges.
If the handle is made of wood, the wood **should be** straight grained hickory.
It **should be** slightly rounded.
They **should not be used** in structural applications **where** there may be long term stresses.
Always use both hands to guide the machine through the cut.
Never plane up a sloping piece of timber.
Make sure that the timber is sound and there are no loose knots or nails.

Expressing sequences
As soon as heat is applied, the glue curing process begins.
As the blade enters the cut, the spring loaded guard is pushed back by the timber.
When the cut is complete, the guard returns to the safe position.
The spread pack of plywood remains under pressure and heat **until** the glue has cured.
The boards are **then** fine sanded on wide belt sanders.
The boards cure **for up to seven days**, depending on their thickness, density and resin type.
Full pressure is quickly applied to reach the desired thickness **before** curing occurs.
After curing, the plywood is trimmed and sanded to complete the production process.
The last stage in production is the inspection and grading process.
The result is a hard, tough, dense and grainless sheet.