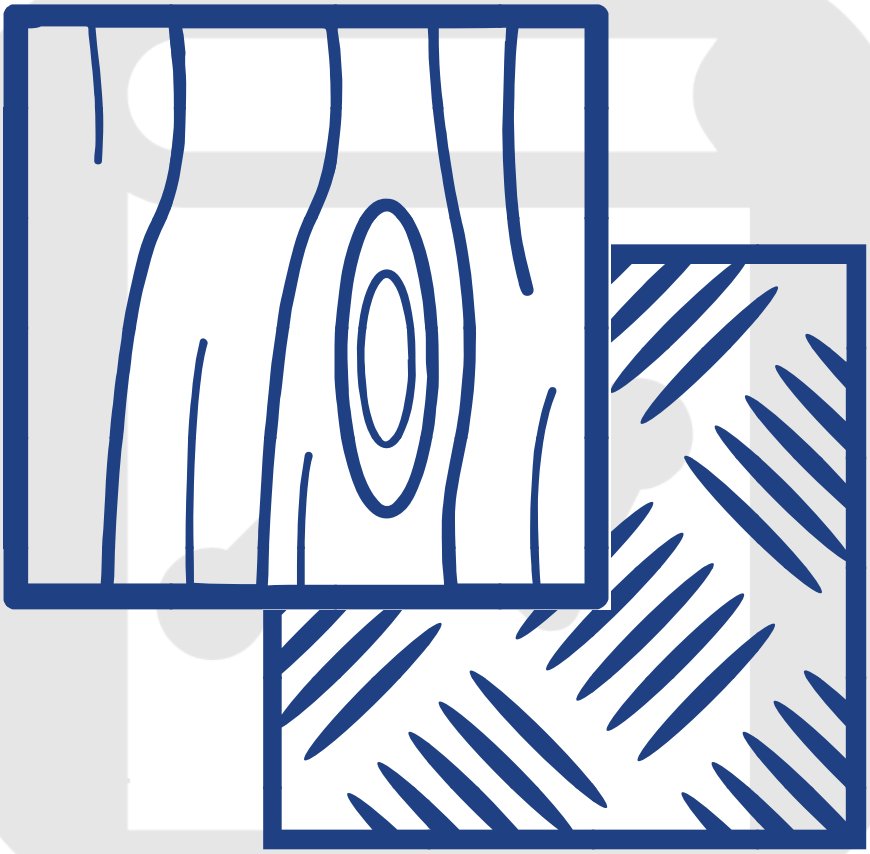
BCATS

BUILDING, CONSTRUCTION AND ALLIED TRADE SKILLS

Timber and Materials



Unit Standard 24360 (v3), **Level 2**

Demonstrate knowledge of timber and other construction materials used in BCATS projects

5 CREDITS

BCITO buildingpeople

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Introduction

This handbook introduces you to timber and to some of the more common materials used in Building, Construction, and Allied Trades Skills (BCATS) projects.

Knowledge of materials is important because it helps you choose the best ones for your project. The wrong materials can cause your project to not be strong enough to use, look unsightly, be unsafe, deteriorate quickly, or not even be able to be completed in the first place. Prior knowledge can avoid this waste of time, effort and money.

To achieve this unit standard, you need to demonstrate an understanding of timber and at least three other materials used in BCATS projects.

How you will be assessed

You need to correctly complete a Knowledge Assessment Sheet.

You need to demonstrate to your teacher/tutor your knowledge of:

- → different types of timber
- → the parts and structure of trees
- → the different strengths and qualities of sawn timber
- → common timber defects and their causes
- → processes for the conversion, treatment, handling, and storage of timber
- → knowledge of at least three other construction materials, including:
  - their structural properties and uses and
  - their safe working, handling and storage requirements.

You can apply this knowledge when you go on to construct a project.

Glossary of terms

Term	Meaning
Air seasoned	Dried under natural atmospheric conditions by stacking in the open air.
Blemish	Anything that adversely affects the appearance of any material.
Borer	The larvae of a wood boring insect which tunnels into wood.
Brittle	Material with a tendency to break or fracture.
Checking	As it pertains to knots in timber.
Clear	Timber which is graded as almost free of visible defects.
Compressive strength	The ability of a material to resist a force that when applied will tend to decrease its volume.
Corrosion	The gradual deterioration of a material, e.g. ferrous metals will rust.
Corrosion resistant	The ability of a material to avoid decay in adverse conditions.
Dressed	Timber that is planed to a smooth finish.
Ductility	The capability of a material to be easily hammered, shaped, moulded or drawn into wire.
Durability	The ability of timber to resist deterioration.
Electrical conductivity	The ease that electricity can travel through a material.
Electrical insulation	The resistance of a material to electricity.
Equilibrium moisture content	The state of timber when moisture content equals that of its surrounding environment.
Ferrous	Metals containing iron.
Fillets	Small pieces of timber used as vertical separators in stacking timber.
Formwork	Temporary support structure for retaining concrete.
Grade	An established quality classification of timber.
Green	Freshly sawn timber.
Hardness	The ability to withstand scratching and indentation.
Heat conductivity	The measure of how heat can travel through a material.
Kiln dried	Timber seasoned in a kiln.

Term	Meaning
Magnetism	The ability of a material to attract iron.
Malleability	The ability of a material to be reshaped.
Medullary rays	Sheet of vascular tissue separating the vascular bundles – parenchyma cells in the plant root and stems that originate from the centre and travel outwards.
Non-ferrous	Metals that do not contain iron.
Non-magnetic	Materials that do not attract iron.
Non–metallic	Materials that contain no metals.
Oxidisation	The gradual deterioration of a material, e.g. non-ferrous metals such as aluminium will oxidise.
Photosynthesis	The process a plant uses to combine sunlight, water, and carbon dioxide to produce oxygen and sugar (energy).
Porous	The ability of a material to absorb air, water and other liquids.
Tension	A force tending to produce elongation or extension.
Thermoplastic	The ability of a material to be remoulded over and over again.
Thermosetting plastic	A plastic that undergoes a chemical change when heated and cannot be reshaped.
Toughness	Strength, resistance to fracturing.

Different construction materials can be used together to make stunning projects. This one combines macrocarpa, paua, and resin with LED lighting.

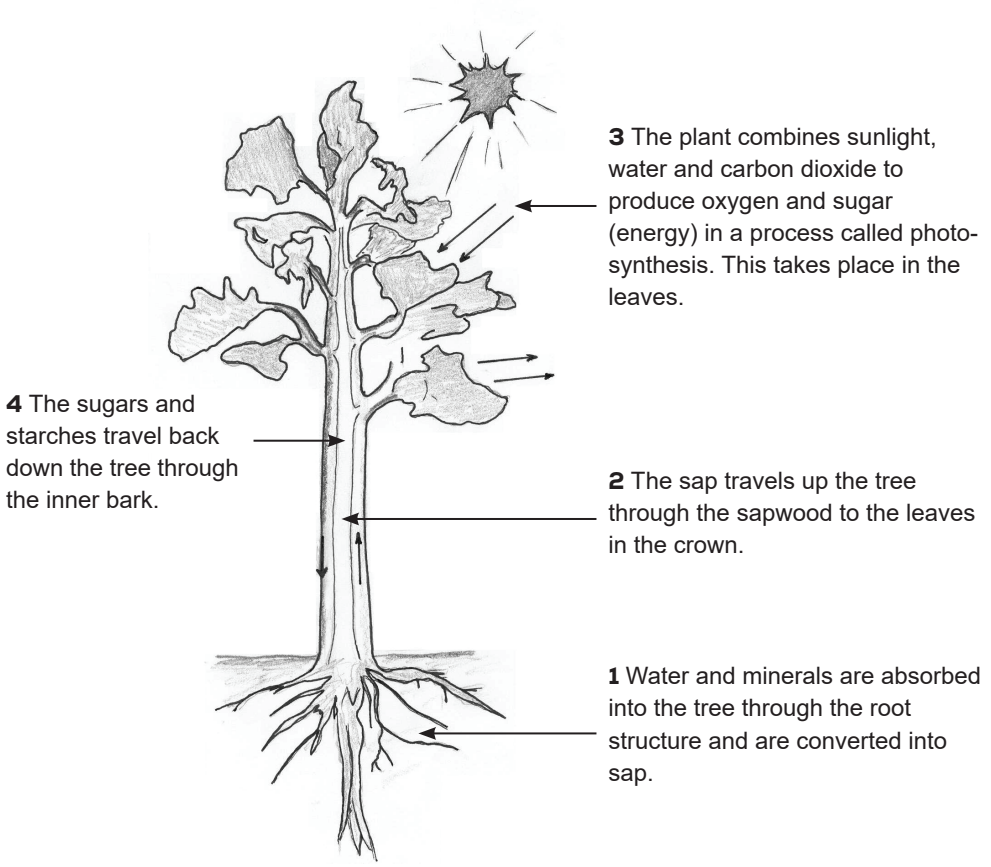
Lucy Scrivener – Awatapu College
River resin table with LED lighting

Tree basics

Timber is wood which is milled and prepared for many different uses. Some of these uses are for buildings, tools, utensils, furniture, fences, and boatbuilding.

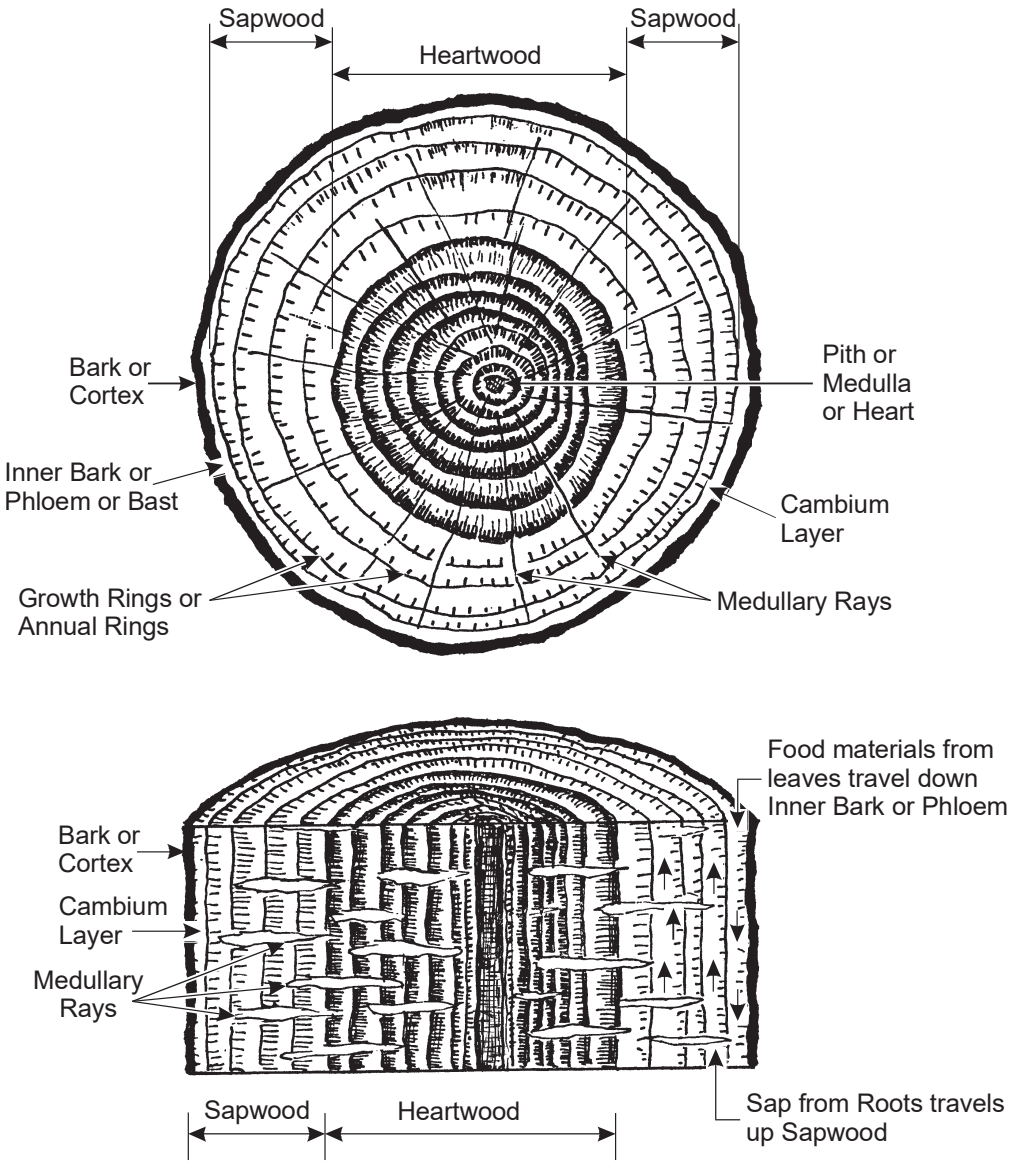
Trees are a naturally renewable resource. They produce timber through a nourishment and growth process called photosynthesis. This takes place in the leaves and involves:

- → light – usually from the sun
- → chlorophyll – the green pigment in a leaf, which acts as a catalyst for the reaction that converts:
  - carbon dioxide, which the plant absorbs through its leaves and converts to oxygen, which the plant excretes.
  - water and minerals into the plant's sap, which contains sugars, (which the plant can use) and starch, (which the plant stores).



Parts of a tree

Trees have different parts that perofrm specific functions to protect or support their growth.



Pith

This is the centre of the tree and is the dead tissue of the original sapling.

Heartwood

The heartwood lies between the sapwood and the pith and is made up of older inactive layers. Its main function is to help the tree to remain straight and upright. This section of the tree generally produces timber which is more durable and resistant to decay and insect attack than timber from sapwood.

Sapwood

This is the newly formed wood which surrounds the heartwood. It is usually softer and lighter in colour. It is through the cells of the sapwood that water and minerals are conducted to the leaves. As the tree grows the sapwood ages, becomes inactive and turns into heartwood.

Cambium layer

The cambium consists of a two-celled layer. The inner layer (called bast or phloem) produces new sapwood, while the outer layer (cortex) produces new bark.

Bark

The outer bark serves as protection for the tree against insects and injury and also prevents the cambium layer from drying out.

Growth rings

Growth rings are made up of cells representing one season's growth. They are divided into two distinct layers:

1. **Spring (early) wood**. This layer is formed during the spring and early summer when the growth rate is at its greatest. It is lighter in colour, soft and has large thin-walled cells.

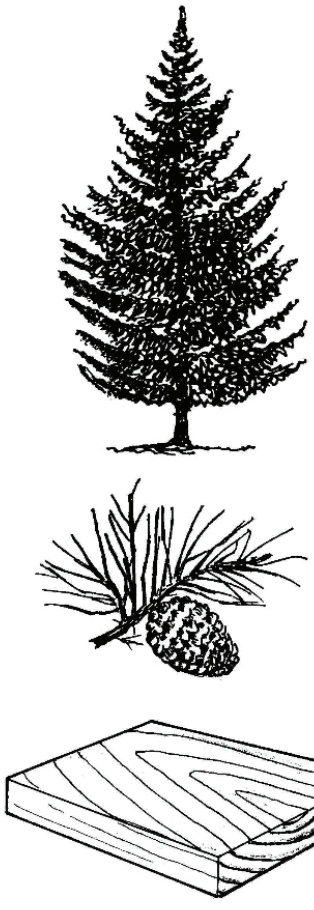
2. **Summer (late) wood.** This layer is formed during the summer and early autumn when growth is slower. It is darker in colour and has small hard-walled cells.

Growth rings vary in width, shape and colour depending on the seasonal conditions affecting growth. In normal conditions these rings are distinct enough to determine the age of the tree.

Classification of timber

Timber is divided into two classes: softwoods and hardwoods. These are botanical terms relating to the cell structure of the tree. They do not relate to the physical property of the timber.

Some hardwoods, such as balsa wood, are very soft in texture, while some softwoods are quite hard, such as matai.

SOFTWOOD	HARDWOOD
	
Softwoods are usually cone-bearing, evergreen trees with needle-like leaves. The timber is generally lighter, softer and weaker than hardwoods.	Hardwoods are usually fruit-bearing, deciduous trees with broad leaves. The timber is generally harder, denser and stronger than softwoods. The timber is often more difficult to season and treat with preservatives.

Trees are further classified as indigenous, exotic or imported.

Indigenous timber	Native to New Zealand.
Exotic timber	Grown in New Zealand but not native to New Zealand.
Imported timber	Grown in a foreign country and imported into New Zealand.

Indigenous timbers (native)

Trees that are native to New Zealand. This timber is becoming harder to obtain because the trees grow slowly and so the felling and milling of native trees is restricted.

There is a thriving furniture industry based around recycled timbers, notably rimu, kauri and matai.

Native softwoods

Rimu	
Appearance	Warm golden colour. The heartwood has a beautiful grain pattern that has been described as one of the most attractive timbers in the world.
Working quality	The heartwood is a fine-grained, medium-density timber. The sap wood is softer and susceptible to insect attack.
Strength	The bending strength, stiffness and resistance to creep (i.e. gradual increase in deflection) when the timber is under constant load.
Structural stability	Very stable when dry.
Design	Can be worked with a range of wood working tools in art, furniture etc.
Aesthetics	Used almost exclusively for high-quality furniture manufacture.
Cost	New timber is expensive. Most timber used to make furniture is recycled.
Availability	Available in small quantities from sustainably managed native forests and from recycled materials.
Durability	Moderately durable.
Uses	Furniture, benchtops, interior panelling.

Totara	
Appearance	Reddish brown and straight-grained.
Working quality	Easily worked, durable and stable, but becomes brittle when dry. Requires special primers when painting.
Strength	Strong and weather and rot resistant.
Structural stability	Stable, endures all weathers.
Uses	The wood is hard and straight-grained and very resistant to rot. Due to its durability, totara is often used for window sashes and sills, feature joinery, and carving.
Availability	Available in small quantities from sustainably managed native forests.

Kauri	
Appearance	Light brown with a light speckle.
Working quality	It is straight grained, easily worked. Moderately durable and stable.
Uses	Restricted to high quality furniture manufacture, boat building, and joinery. Swamp kauri is prized as a material for high quality woodturning.
Strength	Very hard. Slow growth rate provides a strong timber.

Exotic timbers

Trees that are native to another country but grown in New Zealand. Treated exotic timber is now commonly used for construction.

Exotic softwoods

Radiata pine is the most common commercially grown timber in New Zealand. Plantations cover large areas of both the North and South Islands	
Appearance	Lightly coloured with an even texture and very little heartwood.
Uses	Used for building and construction, furniture, joinery, for veneers for plywood, and in manufactured boards such as particle board and MDF. Suitable for practically all building components if correctly processed.
Working quality	Excellent gluing, nailing and machining properties.
Strength	Moderate to low.
Availability	Grown extensively in New Zealand and readily available.
Durability	Natural durability is low, but readily accepts all levels of chemical treatment to resist fungal and insect infestation.
Health and safety requirements	Need to use appropriate breathing protection when cutting and sanding particleboard and MDF.

Douglas fir (NZ Oregon)	
Appearance	A heartwood species, with a rich, red colour, highly textured due to the pronounced early wood/late wood contrast.
Uses	Widely used in the construction industry for light and heavy framing, piling and plywood, such as roof trusses, wall frames, large beams and concrete formwork.
Working quality	Used for structural applications.
Strength	Strong.
Structural stability	Stable structural timber even in subtropical climates.
Durability	Difficult to treat with preservatives so is unsuitable for many applications. Suitable for internal use providing it is out of ground contact and protected from the weather and damp conditions.

Cyprus is a group of timbers that includes macrocarpa and Lawson's cypruss	
Working quality	The wood is prone to splitting when nailed.
Strength	Medium to low density.
Structural stability	Excellent stability.
Uses	Internal and exterior joinery, built-in furniture, exterior weather boards, framing, decking and boat building.
Durability	Natural durability.

Exotic hardwoods

A number of exotic hardwoods such as eucalyptus, walnut and oak trees are commercially grown in New Zealand but only in limited quantities.

Imported Timbers

Imported timber is grown in another country and brought into New Zealand in a finished state. Imported timbers include mahoganies, walnut, oak, jarrah and kwila.

The following examples show how these timbers apply to the New Zealand market:

- The boat building industries, in particular the super yacht manufacturers, often import high-quality timbers to meet requirements for particular jobs.
- Increasing amounts of furniture are being constructed in India and Asia and imported into New Zealand.
- Kwila is commonly used for decking and outdoor furniture.
- Flooring timbers and veneers are often imported from Australia and America.
- Packing cases and pallets, used in the importation of goods from overseas, are often constructed out of quality timbers. It is worth noting that only 5% of the world's mahoganies are used for quality furniture.

Ethical considerations

Some imported timbers comes from endangered tropical rain forests. Think carefully before selecting any of these timbers instead of other options.

Timber production

Plantation forests cover a large part of New Zealand. Radiata pine is the most commonly grown species. The trees are planted at evenly spaced intervals and pruned to encourage straight timber with few defects. Trees are usually harvested by clear felling when they are 18 to 25 years old.

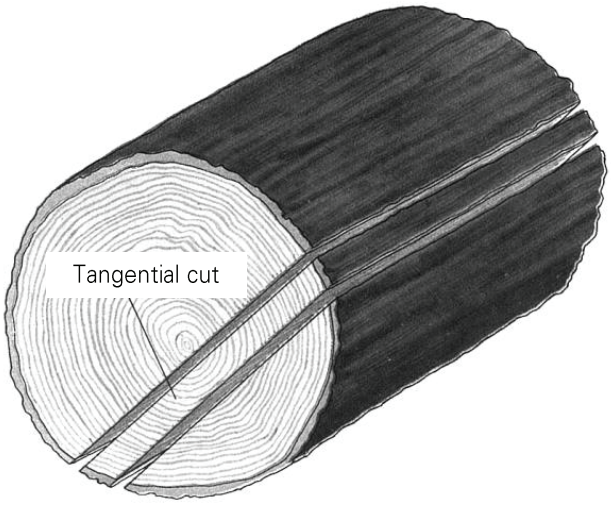
Radiata pine is different in its structure from most timbers because the best and cleanest timber comes out of the sapwood. This occurs through the combination of the tree's very rapid growth and the practice of trimming the branches, which produces low density, knotty heartwood.

Selective logging is used to mill native trees and rarer timbers. It is often carried out in the bush with portable mills cutting the timber on site. Some logs are instead recovered by helicopter and transported to the mill. This method makes the timber very expensive because these extra costs must be recovered from the consumer.

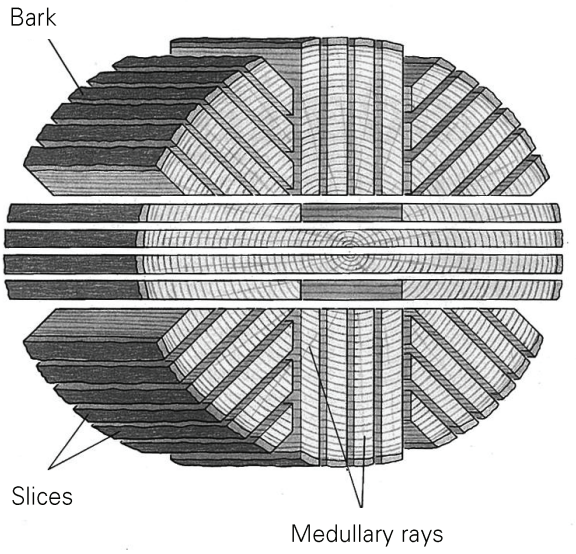
Milling

The milling, or conversion, of timber is the sawing of the logs into workable sizes.

In the conversion process, both flat and quarter sawn boards are produced. The difference between each type is the direction of the growth rings in relation to the wide surface of the timber.



Flat or tangential cut



Quarter saw or radial cut

Flat or tangential sawn

- The surface of the board has an attractive grain pattern.
- This type of cut is strong and suitable for beams etc.
- More likely to shrink and cup away from the heart.
- The growth rings are tangential to the surface of the board.

Quarter sawn or radial cut

- A straight-grained effect is obtained on the surface of the board.
- A better wearing surface is obtained, which is more stable.
- The growth rings pass through the thickness of the board.
- Medullary rays are almost parallel to the face of the timber and produce an attractive effect on some timbers.

Rough sawn timber

Rough sawn timber has a rough surface. It is abbreviated to RS.

Dressed timber

Dressed timber is machined so it is smooth. It is usually dressed on four sides (abbreviated to D4S). This means that the finished size of dressed timber is smaller than rough sawn timber. For example 100 x 100 RS timber is about 90 x 90 D4S timber.

Ordering timber

Measurement and costing

Timber is measured and ordered in the original green, rough sawn size by its:

- cross section in millimetres and
- lineal measurement of length in metres to one decimal place.

  Example: 4.800m of 75mm x 50mm

  - Each size and grade usually has a quoted price per lineal metre.
  - Timber, such as fence posts or rails, has a quoted price per item.
  - Timber can be purchased in packet lots or as individual pieces.

Timber grades

Grades are used to describe the quality of timber.

Board grades – native	Board grades – exotic
Clear	Finishing
Dressing A	Factory
Dressing B	Dressing
	Merchantable

Order details

When ordering timber it is important to include all information relevant to the job requirements. This should include:

- nominal size (this may not be the finished size)
- finish (eg rough sawn or dressed)
- grade
- species
- treatment
- number
- lengths of pieces.

Ordering timber

When ordering timber, the following abbreviations are often used.

Abbreviation	Description	Abbreviation	Description
R/S	Rough sawn	MG	Machine gauged
D4	Dressed 4 sides	DG	Dressing grade
KD	Kiln dried	DRY	Air dried
GREEN	Timber not dry	FJ	Finger jointed
PKT	Packet (approx 450-500m)	T&G	Tongue and groove
SL	Selected lengths	RAD	Radiata pine
BN	Bull nose	RP	Red pine
H1,H3 H4,H5	Treatment level	BT	Boron treated
RAND	Random (a total meterage of timber made up of varying lengths)	EX	"Out of" (e.g. ex 200x40DG=180x35 or ex 100x50MG=94x47)
NZO	New Zealand Oregon		

Below are some typical timber orders in their abbreviated form:

RAD 100 x 50 No.1 R/S GREEN RAND 100m

(Radiata pine, 100 x 50mm, number 1 grade, rough sawn, not dry, random lengths to 100m)

RAD ex 200 x 40 DG H1 D4 DRY SL 3/3.600

(Radiata pine, out of 200 x 40mm, dressing grade, treatment H1, dressed 4 sides, air dried, selected lengths 3/3.600)

RP ex 100 x 25 BN skirting RAND 38m

(Red pine, out of 100 x 25mm, bull nose, skirting, random lengths to 38m)

NZO 94 x 47 No.1 MG GREEN SL 21/2.400

(New Zealand Oregon 94 x 47mm, number 1 grade, machine gauge, not dry, selected lengths 21/2.400)

Seasoning timber

Seasoning is the process of drying out the timber until the timber's moisture content equals that of its surrounding environment (equilibrium moisture content).Trees contain large amounts of moisture or sap. When the tree has been felled, this moisture begins to leave the timber.

Reasons for seasoning

- Timber with equilibrium moisture content is more stable (will move/shrink less).
- Seasoned timber is lighter to handle and easier to transport.
- Seasoned timber is stronger.
- Seasoned timber is less corrosive to metals.
- Seasoned timber is harder.
- Seasoned timber allows easier and smoother machining and sanding.
- Seasoned timber will take paint and other finishes.
- Timber is free from attack by fungus when moisture content is below 20%.

Methods of seasoning timber

There are two main methods used to season timber:

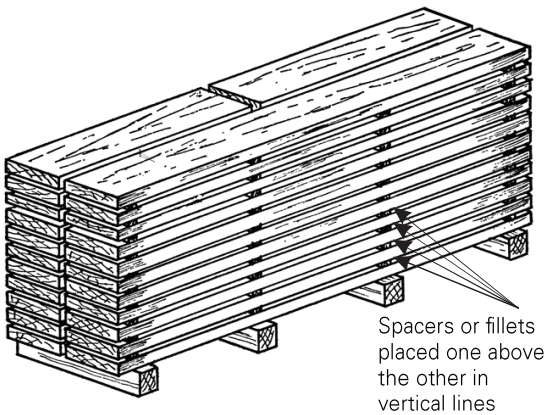
- air seasoning (natural seasoning)
- kiln seasoning (artificial seasoning).

Air seasoning

The boards are stacked with fillets used to create spaces between them to allow for natural air flow over a period of time to dry the boards out.

They can be stacked indoors or outdoors provided there is an adequate air flow through the stack. It needs to be covered to protect the timber from the elements if stacked outdoors.

The longest lengths and heaviest boards should be stacked at the bottom.



The lowest boards must be well off the ground to prevent them absorbing moisture from the ground and to allow air flow.

The ends of boards can be sealed with paint, wax or cleats to prevent them from drying out too fast.

Fillets should be of an even size and stacked vertically one above the other. This helps to keep the boards straight as they dry.

Kiln seasoning

The boards are stacked in the same way as air seasoning. They are then placed in a kiln that heats the timber to dry it.

Conditions needed for kiln seasoning are:

- heat to evaporate surface moisture
- low humidity so the air will absorb the moisture
- air circulation, to remove the evaporated moisture.

Combined seasoning

A combination of the two methods, which involves the timber being air seasoned for some time before being kiln dried. This saves kiln time and money.

Comparison between methods

Air seasoning	Kiln seasoning
Advantages	Advantages
Buildings are not needed.	Quicker and more controlled.
No artificial heat required.	Dried to an exact moisture content.
Method is cheap.	Timber can be supplied all year round.
No risk of case hardening.	Timber is temporarily sterilised. (Wood boring insects will be killed during the seasoning process but they can re-infest the timber at a later date.)
Disadvantages	Disadvantages
Slow and reliant on weather.	Expensive.
Large area of land is required.	Can lead to damage to the timber if dried out too quickly.
Impossible to dry to an exact moisture content.	
Any exposure to weather will darken the timber.	

Timber storage

Timber is a relatively soft material and so must be handled and stored carefully to prevent damage.

Well organised timber stacks

- → Timber will absorb a lot of moisture if it is stored directly on a concrete slab or the ground.
- → Out of level bearers supporting a timber stack will cause the timber to bend or deform.
- → Dry timber may be wrapped in plastic when delivered. Keep the timber sealed until ready for use.

There are two main methods used to stack timber:

Fillet stacking – as mentioned in the air and kiln seasoning section.

Block stacking – boards of the same width and thickness are stacked together, without fillets, and covered.

Block stacking	
Advantages	Disadvantages
• it takes less space • boards are less likely to warp • it is easier and quicker to stack the timber.	• further seasoning will be slow.

Timber handling

There are a number of simple precautions that can be taken to prevent injury and long term health problems when using any timber product.

- Wearing gloves and overalls when handling rough sawn timber will prevent splinters and the possibility of infection, especially from some of the imported species.
- Always limit exposure to wood dust when working with timber. Use respiratory protection, such as a dust mask.

Timber treatment uses chemicals that may be harmful. When working with treated timbers, always:

- reduce contact with the timber by wearing gloves, long sleeved overalls, goggles and a dust mask
- wear protective glasses and a filter mask when sawing, sanding or machining
- dispose of off-cuts and waste in an approved landfill (Never burn them – it would release poisonous vapours into your neighbourhood.)
- wash your hands before using the toilet, smoking, drinking or eating
- wash work clothes separately
- never use treated timber for food containers
- ventilate work spaces as much as you can
- avoid working with solvent-damp timber.

Important

Tell your teacher/tutor if you experience skin irritation, headaches or light headedness when using treated timber. These are signs of poisoning. Don't handle or use the material until the types of personal protective equipment (PPE) you were using are reviewed and improvements made to your level of protection.

Moisture content (MC)

'Moisture content' is a term used to describe the amount of moisture or sap in timber. It is always expressed as a percentage of the timber's dry weight; for example, 25% moisture content.

Timber absorbs moisture during wet and damp weather and in high humidity. This can cause the timber to swell, which may cause doors and drawers to stick. It dries out and shrinks during hot, dry, windy weather.

Equilibrium moisture content (EMC) is reached when the moisture in the timber is in balance with the moisture in the surrounding air. No further loss or gain of moisture will take place at this stage. Movement in timber can therefore be minimised if the timber is seasoned to the atmospheric conditions of where it is to be used.

Measuring moisture content

The amount of moisture in timber can vary considerably. This amount can be determined by one of two methods:

1. Moisture meter method. This measures the electrical resistance of the timber, which increases as the timber dries out. Steel pins are forced into the timber and the resistance to the current flow between the pins is measured.

2. Oven dry method. A sample of timber is weighed then dried thoroughly in an oven. It is then weighed again. The moisture content is found by using the formula:

$$\text{MC (\%)} = \frac{\text{Initial weight of sample} - \text{Dry weight of sample}}{\text{Dry weight of sample}} \times \frac{100}{1}$$

Example	
Wet weight of sample (W)	= 650 gm
Dry weight of sample (D)	= 500 gm
MC	$= \frac{W - D}{D} \times \frac{100\%}{1}$
	$= \frac{650 - 500}{500} \times \frac{100\%}{1}$
	$= \frac{150}{500} \times \frac{100\%}{1}$
	= 30%

Application of moisture content levels

The acceptable level of moisture content in timber will vary depending on where the timber is to be used.

Timber use	MC
Fencing and framing timber – where further drying can take place	20 – 25%
Exterior joinery, gates, garden furniture	16 – 17%
Interior joinery and flooring	13 – 14%
Furniture	12 – 14%
Woodwork in a centrally heated building	10 - 12%

Shrinkage

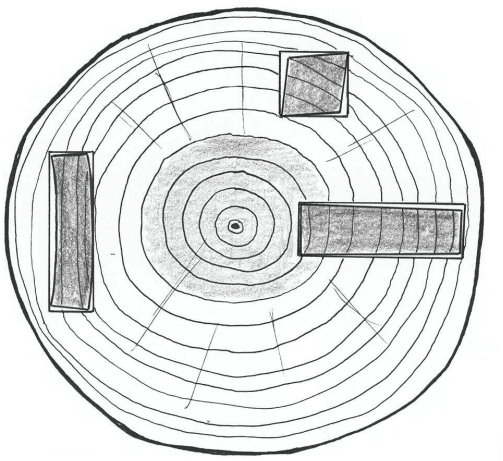
- Shrinkage will occur in timber during seasoning.
- Free moisture that is contained in the cell cavities can be removed quickly without affecting the timber. It will reduce its weight.
- Fibre saturation point is reached when the moisture content is reduced to approximately 25 to 30% (the remaining moisture in the timber is contained in the cell walls).
- Further drying out below this point will cause the cell walls to release moisture and the timber will shrink.

Most timber shrinkage of occurs in sapwood because:

- the sapwood contains the most moisture
- it is softer and lighter than the heartwood.

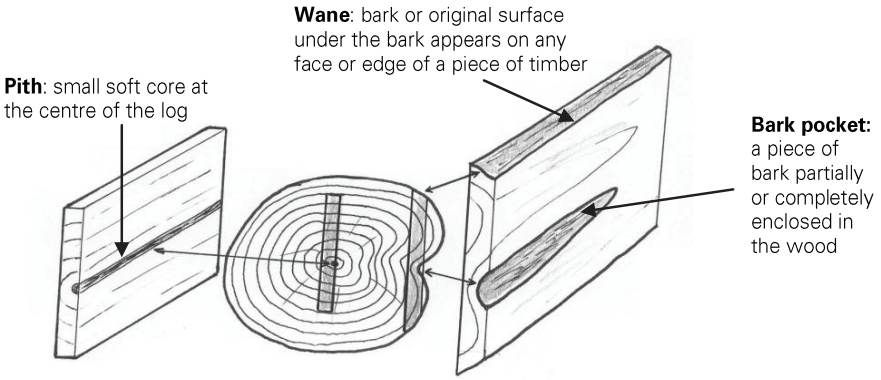
Maximum shrinkage occurs around the curvature of the growth rings, followed by radial shrinkage. Timber shrinks very little in length.

On a flat sawn board, there are more sapwood cells on the outside of the board causing that area to shrink more than the heartwood area. This results in 'cupping'.

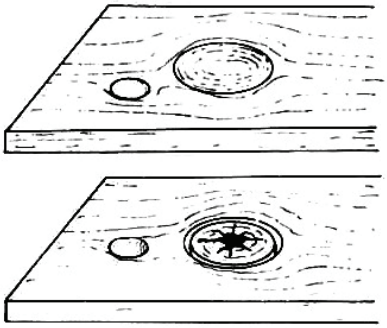


Timber defects

A defect is any irregularity that occurs in or on the timber and has the potential to lower its commercial usability by reducing its strength, usefulness or appearance.



Knots



Knots are formed from a section of a branch that is embedded in the wood of the tree trunk. It is exposed when the log is milled. The timber is weakened around the knot causing:

- → reduction of load-bearing capacity
- → distortion of the grain fibres
- → shrinkage around a knot during drying or seasoning
- → difficulty in dressing and finishing of timber.

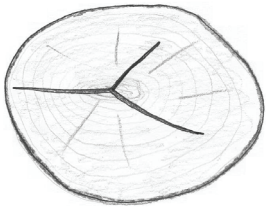
Knots pose a greater risk when the timber is in tension rather than compression. For example, a knot that is located centrally or in the lower half of a beam or lintel will cause significant structural weakness.

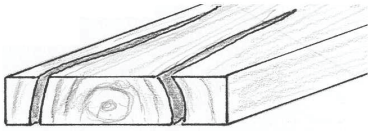
Cross grain

Grain running across the piece of timber from one face to the other or from one edge to the other. Cross grains reduce the strength properties of the wood.

Shake

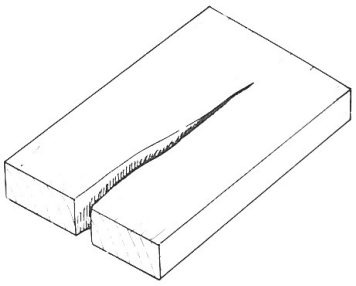
A separation of the wood fibres originating in the standing tree or the felling process. Seasoning does not cause it.





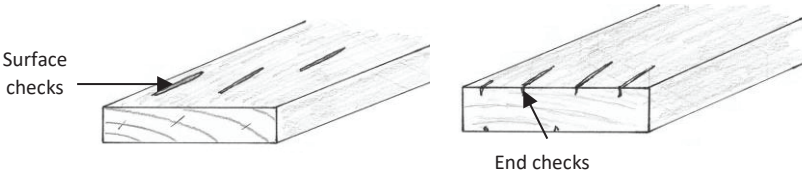
Split

A lengthwise separation of wood fibres through a piece of timber from one face to the other. Timber seasoned correctly reduces the likelihood of splitting.



Check

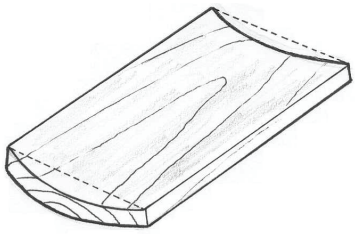
Similar to a split but the separation does not extend right through the timber. Timber seasoned correctly reduces the likelihood of checks occurring.



Warp

Any variation from a true flat surface. The four types are:

1. **Bow**: curving flatwise along its length.
2. **Crook**: curving lengthwise along its length.
3. **Cup**: curving across its width.
4. **Twist**: spiral curving along its length.



Decay

The decomposition of damp wood by fungi.

Insect damage

There are two main types of timber-destroying insects in New Zealand.

1. **Borer** – there are a number of species.

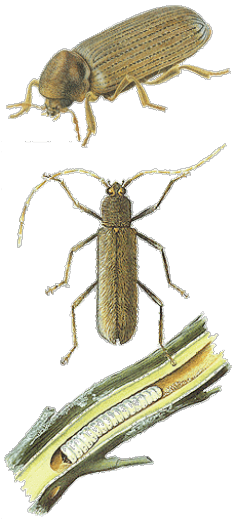
2. **Termites** – common in Australia and in some parts of New Zealand.

Comparision - borers and termites	
Borers	Termites
Borers live as individuals.	Termites live in colonies.
Damage is usually limited to small tunnels of varying lengths running along the grain.	Damage is usually cavities, which can be quite extensive.
Flight holes appear on the darker side of the infested timber.	There is very little outward sign that the timber is infested.

The most common wood boring insects that attack New Zealand timbers are discussed below.

Common house borer

Anobium Punctatum



This is the common house borer. It attacks old, well-seasoned timber, preferring the sapwood of softwood timbers. It is a pest of major economic importance in New Zealand. The beetle is 3 to 5mm long, dark-brown/black in colour.

The adult house borer lays an average of 30 eggs. The egg, which is 0.55mm long and 0.35mm wide, is laid on the surface of the wood, in a crack, crevices, end-grain timber, split or old flight hole, but never on sealed, painted or varnished surfaces.

After 2 to 3 years of tunnelling in and feeding on the timber, the lava hollows out a pupal cavity just below the surface. The pupa changes into a beetle and chews its own exit hole, a round hole 1 to 2mm in diameter. The adult beetle can gnaw their way out through paints, wallpapers, varnishes, linoleums, wallboards, and plasters. They have even been known to exit through sheet lead and Formica.

The borer flight season is September-April. They die within 3 to 4 weeks of emerging to breed.

Life cycle

- → Egg-larvae 14-28 days
- → Larvae-pupae 2-3 years
- → Pupae-adult 21-60 days
- → Adult-beetle 3-4 weeks

Two toothed longhorn

Ambeodontus Tristis (New Zealand Native)

The two tooth longhorn would be one of the more destructive wood boring insects in New Zealand. This insect prefers the sapwood of softwood timbers but will also attack the heartwood.

- Lives 5 to 7 years inside wood.
- Exits March to May.
- Oval holes 2 x 6mm.
- Attacks swoft and heartwood.

The early larval tunnels run predominantly with the grain but later tunnels run in all directions. Severe infestations may reduce timber to a thin outer shell. The first sign of an infestation may be the adult beetles' exit holes.

Two-toothed longhorn beetle and oval exit-hole.

Photo courtesy of *Forest and Timber Insects in New Zealand No. 26:Two-toothed longhorn* (Revised 2009 Based on G.P. Hosking (1978)).

Additional points of interest

- Most districts of New Zealand provide the perfect climate for borer.
- Damp, humid areas create ideal conditions for borer attack. A hot, dry climate will not support any significant borer infestations.
- The worst affected areas are central and upper North Island, particularly Waikato.
- The least affected area is Central Otago.

Timber that is infested with wood destroying insects should be removed from the job and replaced with treated timber.

Termites

Soldiers are 5-7mm long with brown heads and long jaws

Photos courtesy of the Ministry for Primary Industries.

Alates are brown with two sets of light brown wings. Approx. 12mm long with wings laid flat.

New Zealand has three species of native termites that are not considered to be destructive and do not form colonies. Australia has a species of termites that causes considerable damage to buildings. These were imported to New Zealand in infected timber and can be found in some parts of New Zealand.

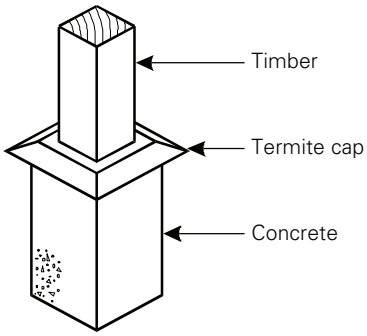
They are subterranean (earth-dwelling) termites. Often the only sign of infestation is subterranean termite "mudding". This is caused by termites packing mud into gaps in timber. Sometimes mud tunnels up walls or across open ground can be seen.

If you suspect you've seen these termites (photos above left), do not disturb them or attempt to kill them. Call the Ministry for Primary Industries (MPI) on 0800 99 66 so they can arrange to have them professionally eradicated.

The subterranean termites like to establish their colony under a building. From this colony the workers build tunnels to the source of the wood on which they feed. They will build these tunnels over obstructions and once they gain access to the timber they will remove the interior wood, leaving only a thin exterior veneer or shield.

Termite prevention and control

To prevent the attack on timber by termites, unwanted timber should be removed from beneath and around buildings. These dark and damp locations are an ideal breeding ground for insect infestation.



Unwanted timber could include scraps that have been left lying around, stacks "put aside for a rainy day", or old tree stumps. If any timber is found that seems to be infested, it should be burnt. If a termite colony is discovered, call MPI.

If building in a known termite area, foundation walls and piles should be fitted with termite caps. Caps will help prevent invasion by earth-dwelling termites.

Note: It is necessary when ordering timber to specify the preservative treatment for the situation in which it is to be used.

Fungal infection (rot)

There are three broad types of fungi that cause rot.

Soft rot fungi (wet rot) attacks timber with a moisture content above 60%. Soft rots are usually found on timber in contact with the ground. They tend to be more resistant to fungicides than brown rots or white rots. In boron-treated timber, soft rot is the common form of decay. Timber infected by soft rots often shows little sign of decay. It is best to investigate if timber has darkened or appears to be greyish. The decay is taking place from within the cell wall and only becomes apparent when prodded with a sharp object. Timber can easily be carved with a sharp knife in its advanced stages of decay.

Fracture surface of timber with soft rot.

Photo courtesy Department of Building and Housing

White rots appear to bleach the timber, giving decayed timber a yellow-white fibrous appearance. The colouration is because they consume both the lignin and the cellulose. White rots commonly operate at mid to higher moisture levels. They are often found in decaying timber weatherboards and external timber joinery.

Brown rot (dry rot) is less common in New Zealand than other forms of rot. It is often called 'dry rot' because it can transport the water it needs and so can attack even dry timber. It draws the moisture through fine tubes (Hyphae) back into the timber. In its early stages it is invisible to the naked eye. Affected timber becomes darker and develops cube-like cracking as it dries.

Brown rots are considered to be more severe than other types of rots. This is because they decay timber more rapidly, and once started, they tend to operate at lower moisture levels than other rots. All timber affected by dry rot must be removed and burned.

How can you prevent fungi attack?

Choose timber that has been treated for the environment and use it is intended for.

- → Keep the timber dry.
- → Ensure adequate ventilation to reduce moisture content.
- → Always follow best practice and use only approved materials when constructing buildings.

What should you do when you find infected timber?

Contact a professional building surveyor to arrange testing to confirm what type of mould it is and to give recommendations of how to remedy the damage.

Wood preservation (timber treatment)

While the heartwood of most native timbers is naturally durable, the sapwood of both native and exotic softwood is not. These timbers are prone to damage from decay and insects and must be chemically treated if they are going to be exposed to damp or wet conditions.

Wood preservation is a process where timber is made poisonous to wood destroying organisms. This makes the timber more durable and increases its commercial usability.

There are various types and grades of treatment available, with each grade being suited to a particular situation. The chart below lists the different grades and when to use them.

Hazard Class	Exposure Conditions	Typical Uses	Biological hazard
H1.1	Protected from the weather, no risk of dampness but borer protection required.	**Non-structural:** interior joinery such as door frames, stairs, architraves, skirtings and cornices, built in or freestanding joinery items (excluding timber window reveals and frames).	Borer
H1.2	Protected from the weather, above ground, risk of moisture exposure conducive to decay.	**Structural:** internal wall and floor (excluding piles) timber framing and trusses, plywood sheet bracing, framing for enclosed decks and balconies.	Borer, fungal decay
H2	Similar to H1 but includes treatment against termites		Borer, termites, fungal decay
H3.1	Exposed to the weather, above ground, periodic wetting.	**Non-structural exterior:** timber cavity battens; fascias, weatherboards, facings, exterior joinery, and other painted trim.	Decay fungi and borer
H3.2	Exposed to the weather, or protected from the weather but with a risk of water entrapment, above ground.	**Exterior including structural:** decking, fencing, pergolas, stairs, rafters exposed to the weather, uncoated or stained radiata pine weatherboards and trim.	Decay fungi and borer
H4	Exposed to the weather, in high decay areas such as contact with the ground or in fresh water.	Fence posts, landscaping timbers, retaining wall horizontal members, garden edging, planter boxes.	Decay fungi and borer
H5	Severe decay areas such as in contact with the ground or in fresh water.	**Critical major structural:** house piles, retaining wall poles	Decay fungi and borer
H6	Exposed to regular immersion in sea water or estuarine ground.	**Marine:** wharf piles, sea walls	Marine wood borer and decay

Methods of timber treatment

The chemicals commonly used for timber preservation treatment include:	
Boron salts	Widely used in New Zealand and to a lesser extent in Australia. They are used where the main hazard is insect attack but also provide some protection against fungal decay. Freshly sawn unseasoned timber is soaked in solutions of boron salts. The timber is then allowed to dry. Prolonged exposure to moisture can cause the salts to leach out of the timber so this treatment should only be used on timber that will remain protected from the weather in use, so for Hazard Classes H2 and below.
Copper-chrome-arsenate (CCA)	The most widely used treatment. Because the treatment is resistant to leaching, it can be used on timber that will be exposed to the elements or used in ground. The chemicals are forced into the timber under high pressure. Once these chemicals become fixed in the timber they won't leach out as a result of wetting under normal conditions. The length of time taken to fix chemicals in the timber varies from weeks to months, depending on weather conditions.
Copper-based alternatives	Chrome and arsenic-free, such as copper azole CuAz and Alkaline copper quaternary. These are alternatives where environmental legislation or customer preference restricts the use of CCA. They are applied to the timber under pressure.
Light organic solvent-borne preservative (LOSP)	A solution of fungicides and/or insecticides in a light organic solvent, such as white spirit, is applied by a vacuum process. Because it is spirit-based, it avoids wetting timber that is already dry. The chemical preservatives are not fixed. This means water can leached it out. LOSP-treated timber must therefore be protected by a three-coat paint system if used externally. LOSP treated timber keeps its original appearance and does not swell with the treatment. It is used for external joinery, such as windows and fascias and for timber cavity battens. The solvents must be fully evaporated before paint, stain or glues are applied.

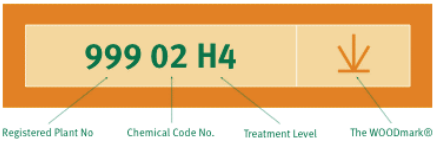
On-site treatment

Preservative application methods used for on-site remedial work include brush-on and dip diffusion.

- → If large section timbers are to be cut, chased, bored or machined after H3 to H6 treatment, the area exposed should be protected with a paint-on preservative such as copper napthenate.
- → Cut ends of treated softwood posts, stumps and piles must not be embedded in the ground. This is because site-protected applications cannot give adequate protection. If there is no other option than to use the cut ends (such as having a middle piece of timber), treating it with timber preservative will help delay it rotting.

Marking

Treated timber should be marked clearly with an identification branding mark and colour coding. These are defined in the Building Code. Sample markings are demonstrated on the right.



Introduction to other construction materials

As with timber, other construction materials often contain toxic components or can be dangerous if not handled correctly. Always use appropriate personal protection equipment (PPE).

Manufactured construction materials, such as cement and paint, will always have manufacturer's instructions for its safe use and handling on the container it comes in. They will also always have Product Data Sheets and/or Safety Data Sheets.

Safety Data Sheets and Product Data Sheets provide a summary of all the technical information for a product. They include a description of the product, its typical physical characteristics and how it is to be safely used.

Product Data Sheets

Product Data Sheets are a manufacturer's summary of the performance and other technical characteristics of each construction product, material or component.

Product Data Sheets usually include a description of the product, how to use it, when to not use it, brief safety instructions, how to dispose of it, and any other information legally required for that type of product. Using a product according to the Product Data Sheet's specifications should result in it performing and lasting as it was designed to.

Safety Data Sheets

A Safety Data Sheet, sometimes called Material Safety Sheets, is a document provided by manufacturers with details of the physical and chemical properties of the product.

Safety Data Sheets are designed to protect the health and safety of people in the workplace by providing information on the hazardous substances contained in a product and outlining how to safely use, store, transport and dispose of them.

Safety Data Sheets also contain emergency procedures, with directions for spills, ingestion, skin contact, fire etc. To make sure they comply with current standards, Safety Data Sheets shouldn't be more than five years old.

Concrete

Concrete is one of the most valuable and versatile of construction materials. It is used extensively for a wide range of construction work such as foot paths, driveways, roads, dams, residential and commercial construction – floors and walls; foundations and footings for posts, fences and block walls; and even for boat hulls.

Concrete can be purchased ready mixed and delivered to the site in a concrete truck or, for smaller jobs, it can be mixed by hand, usually with a concrete mixer.

Poor concrete is made up of water, cement, course aggregate and sand. Good concrete is made up of exactly the same materials. The difference is that good concrete is made from carefully selected materials and care is taken in proportioning, mixing, placing and curing the concrete.

The ingredients are mixed together in controlled proportions to form a plastic mass. This combination sets off a chemical reaction which hardens the cement, bonding the other components together and creating a rock-like material.

Cement is the main ingredient of concrete.

- It is used to bond all of the materials together.
- It is supplied in a powdered form, usually in 40kg bags.
- When mixed with sand and water, cement forms mortar, which is used by bricklayers for joining bricks and block work.
- When mixed with the correct quantities of sand, aggregate and water cement forms concrete.

Cement must be stored off the ground in a dry environment. Keep containers closed and airtight when not in use. Sweep up any excess and dispose of it where your teacher/tutor tells you it is safe to put it.

Aggregate is used to form the body of the concrete.

- It consists of stone material, such as rock or crushed gravel.
- The coarser stones provide bulk.
- It must be clean, strong and hard.

Sand and aggregate must be covered and stored in containers or on a hard surface.

Sand is used to fill in the gaps between the coarser stones.

- This adds to the strength of the concrete.
- Like the stones, the sand must be clean.

Builder's mix is the term given to pre-mixed sand and aggregate available from building suppliers.

Water combines with the cement to form a cement paste. The ultimate strength of hardened concrete is determined by the strength of the cement paste. The cement paste strength is governed by its water content. The lower the total mix of water, the greater the ultimate strength potential.

Ratios

The most commonly used mix by volume is 1:2:4 – one measure of cement, two measures of dry sand and four measures of aggregate. These ratios may vary depending on the task and product. If using builder's mix, the most common ratio is 4:1 but this, again, depends on what the concrete will be used for.

Note: Too much sand will spread the cement too thinly and a weak mix will result. Too much coarse aggregate will produce concrete that is full of holes. Too much water will reduce the strength of the concrete.

Always read and follow the instructions written on the bags of cement.

Mixing concrete

Below is a basic guide to how to make concrete. Follow the manufacturer's instructions for the cement you're using.

Hand mixed – either in a wheelbarrow or on a board (on the ground).

- pre-mix the dry ingredients
- add 10% more cement
- form a crater and add water gradually
- work in water and turn over several times until thoroughly mixed – use a shovel.

Machine mixing – in a concrete mixer:

- add ¾ the volume of water
- add half of the required aggregate
- add all the cement
- add the remainder of the aggregate
- add the rest of the water until the mixture falls cleanly from the top of the rotating drum
- mix for at least 2 minutes.

Placing and finishing concrete

Your teacher/tutor may give you instructions on how to place and finish concrete for a specific project. The below is a brief guide that applies to all projects.

Placing

Concrete starts to set as soon as it is mixed. Place it as soon as possible after mixing. It needs to still be in its 'plastic' state, which is when it is soft and workable.

- Deposit carefully to avoid segregation of concrete (large aggregates being separated from fine).
- Work into all corners and around steel.
- Straighten out or level off the concrete by screeding to the formwork.

Finishing

Float the concrete off to obtain a smooth finish. This can be done with a wooden, steel or motorised float. Use long sweeping strokes to gain the best effect.

Curing concrete

Curing is the process which controls the loss of moisture from concrete after it has been placed in position, providing time for the hydration process to occur. This takes time - often weeks.

The curing process is only finished once the concrete has achieved its potential strength. How long this takes will depend on the properties required for the finished concrete project.

Concrete must be kept wet during the curing period. While there are other methods for doing so, three common methods are:

- covering the concrete with a waterproof cover to prevent excessive moisture loss
- continuously wetting the surface, preventing the loss of moisture from the body of the concrete (ponding or spraying the surface are two ”wetting" methods which can be used) and
- using liquid curing compounds.

Strength

Concrete is strong in compression but weak in tension. Combining steel, which has a high tensile strength, to concrete creates reinforced concrete. This makes paths, driveways, and building foundations stronger than if concrete was used by itself.

- Always keep steel rods, bars, and wire sheets well clear of the ground and the face of the concrete. This will protect it from rusting from ground moisture and exposure to the air.

Cement health and safety

Wet cement, especially in plastic concrete, mortar or slurries, can dry the skin and cause caustic burns. Direct contact with the eyes can cause irritation. Cement dust can cause inflammation of the interior tissue of the nose and also the eye cornea.

Always wear a mask when mixing concrete to prevent inhaling the silica dust in the cement.

One way you can help ensure your own safety when mixing and using concrete is to use Personal Protection Equipment (PPE). You will likely need to use at least:

- hearing protection
- safety boots or covered shoes
- dust masks
- gloves and/or barrier cream
- safety glasses (even if you wear prescription glasses, you must still use safety glasses)
- apron or overalls.

Metal

This section on metals add another layer of knowledge to what you learned when you did the Level 1 unit standard, *Demonstrate knowledge of construction and manufacturing materials used in BCATS projects* (US 25355).

If you have not had the opportunity to achieve the Level 1 unit standard, you may access the student resource for it through your www.mybcito.nz login.

Mild steel

While steel has been used extensively in commercial construction for a long time, residential homes have been traditionally constructed out of timber. Steel framed residential housing is becoming more common, especially following the problems with the leaky houses and their rotten framing timber.

Mild steel will rust if it is in contact with water but can be made quite resilient if galvanised.

Galvanised steel can be used in a wide range of outdoor applications that are exposed to all aspects of weather, including, structural framing, hand rails, clothes lines and boat trailers.

Mild steel is available in a wide range of forms including sheet metal, bright and black bar and extruded sections, such as angle, channel and tee.

Mild steel can be joined by welding, riveting, screwing and bolting members together.

Aluminium

Aluminium is a lightweight, soft metal with a high strength to weight ratio. It is corrosion resistant and is also a good conductor of heat and electricity.

It is used for boat building, joinery, and for hardware, such as ladders. It is being constantly developed and modified for use in a wider range of applications.

It is available as sheet, plate, bar and extruded sections. It can have a wide range of finishes, including powder coating, painted, and anodised.

It is important to not allow aluminium to come into contact with other metals. It is vulnerable to a chemical reaction, called galvanic reaction, which happens when it comes in contact with other metals. This reaction will break down or corrode the aluminium.

Aluminium is also more difficult to join than steel. Specialised welding equipment, for example TIG and MIG welding systems, rivets, screws (stainless steel) and bolts are most commonly used.

Stainless steel

Stainless steel is an alloy of steel, zinc and chromium. It is a hard, tough and corrosion resistant material. It does not stain, corrode or rust as easily as ordinary steel.

It is available as sheet, plate, bar, wire and tubing.

There are various grades of stainless steel available to most applications.

It is widely used where a strong, hardwearing material is required, such as in kitchens and bathrooms, furniture, hardware, industrial equipment and marine assembly.

It is difficult to cut or file and requires specialised welding skills to join it. TIG is the most commonly used welding method.

Copper

Copper is a reddish coloured metal with excellent heat and electrical conductivity properties.

It is corrosion resistant, easy to work and shape.

It can be easily joined using solder or by brazing.

It is available in wire, sheet, tubing, and pre-formed fittings.

These properties it widely used in construction, mainly for electrical and plumbing such as water pipes and electrical wiring. High quality spouting and flashings are often also made out of copper.

Brass

Brass is an alloy made up of 65% copper and 35% zinc.

It is corrosion resistant, harder than copper, casts well, is easily joined, and is a good conductor of heat and electricity.

It is used for castings and forgings, such as for tap fittings.

Bronze

Bronze is an alloy made up of 60% copper and 40% tin. Bronze has traditionally been used for casting and sculpturing. Modern bronzes come in a range of variations which can affect the characteristics, whether it is providing a higher resistance to wear, better machinability, less corrosion in water, etc.

Safety with metals

As with any material, there are risks associated with handling and working with metals. Serious injury can be avoided if appropriate safety precautions are taken when handling and working with them.

Your teacher/tutor will teach you how to handle, use, and store the metals available in your workshop.

One of the essentials is for you to look after your personal safety with the help of personal protective equipment (PPE). With metals, protective clothing to wear includes:

- overalls
- leather apron
- leather gloves
- steel capped boots
- flameproof clothing.

Depending on what you're doing with the metal, you may need to use some or all of these types of PPE:

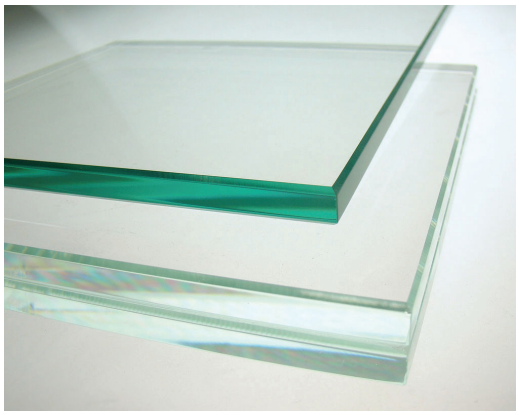
- face shield
- safety goggles
- ear muffs
- respirator
- welding helmet.

Storage

It is recommended that sheet metal is stored in racks at an angle of 3 to 5° from the vertical and a protective barrier is in place to prevent the sheets from falling sideways.

Steel rod should be stored in vertical wall mounted racks according to size.

Glass



A variety of types of sheet glass

Glass is a versatile, hard and transparent material. It is very brittle, can easily be broken and requires specialist equipment for drilling holes, polishing or bevelling edges.

Basic sheet glass is commonly used in windows, but other grades of glass are manufactured to meet requirements as safety glass, rolled plate, polished plate, float, laminated, self-cleaning, soundproof, insulating, tinted or stained glasses. Glass can also have decoratively textured surfaces or be coloured for lead lighting.

Safety glass should always be used in situations where it could be broken and injure people.

Advances in glass-making technology have provided forms of glass that greatly improve the comfort and environmental impact of homes. For example, double glazing improves a home's temperature and energy efficiency.

When working and processing glass, cuts from sharp edges are always a possibility. Work safely at all times. Listen carefully to and follow your teacher/tutor's instruction on how to do this. Protective clothing and equipment (including full overalls, face shield, leather apron and gloves) must be worn when handling glass.

Cutting glass

1. You must wear safety glasses and sturdy footwear. Always wear gloves when handling the cut edges.
2. Clean the surface, but only along where you plan to score. To clean the score area, just run your finger along the surface of the glass.
3. Select a good quality glass cutter and hold it like a pencil.
4. Align the wheel to the glass.

5. Pull the cutter along the surface, applying an even pressure. Listen for the clicking or gritty sound of the small carbide wheel permeating the smooth surface of the glass. The less sound, the better the score. If you push too hard (very common), the cut gets "hot", meaning it snaps and pops. You should be aiming for a score that is uniform in depth and width so that the glass will break exactly as desired. If you are too hard in one spot and perfect in another, microscopic imperfections will cause a jagged cut.

6. Score along a straight edge or ruler. Use something with a profile that is high enough not to interfere with the wheel on the cutter. Practise on scrap glass until you feel confident to produce a score that looks like a barely visible scratch.

7. Grasp each side of the cut, as if you were trying to break a potato chip in half with two hands. It takes minor pressure. Simply twist your wrists (your right wrist will turn clockwise and your left will turn anticlockwise) while keeping your elbows fixed in position. The glass should open up along the glass cutter score.

8. Lastly, use a fine sandpaper or sharpening stone to remove the sharp edges of the cut. Sanding these edges reduces the risk of severe cuts. Sanded glass is also less likely to chip along the edges and has some added strength. Wear gloves when sanding or you will get cut!

Storage

Store glass sheets in racks at an angle of 3 to 5° from the vertical and that mesh fencing or another similar type of barrier is in place to prevent the glass from falling out sideways.

Composite materials

There are many types of composite materials. Only a few of the most common ones are summarised in this handbook.

Glass reinforced plastics

Fibre glass is a material made up of extremely fine fibres of glass. It is strong and has excellent insulation properties.

It comes in a mat form that, when reinforced with polymer or epoxy resins results in a composite material, properly known as glass-reinforced plastic (GRP), or - more commonly - "fibreglass".

As with many other composite materials (such as reinforced concrete), the two materials act together to balance each other's weaknesses. . Plastic resins are strong in compressive loading and relatively weak in tensile strength. Glass fibres are very strong in tension but have no strength against compression. Combining the two materials creates a material that effectively resists both compressive and tensile forces.

Health and safety

Suitable PPE for working with glass reinforced plastics includes:

- overalls
- impervious gloves
- respiratory protection, preferably a replaceable filter respirator
- safety goggles or full face mask
- hearing protection when machining.

Safe handling and storage

- Work in a well ventilated, specially designated area. Have emergency equipment readily available.
- Clearly label containers and keep them closed when not in use.
- Store containers in a cool, well ventilated area.
- Always wash hands before eating, drinking and using the toilet.

Fibre cement sheets

Fibre cement sheets are available in a wide range of shapes and sizes. Their uses range from weatherboards to wall, shower and soffit linings, bracing panels, and fire and acoustic rated walls.

Fibre cement products have some distinct advantages over traditional construction materials. A 16mm thick fibre cement weatherboard won't crack, warp or split. It also has strong shadow lines and is virtually indistinguishable from traditional timber weatherboards.

Cutting fibre cement sheets

Fibre cement sheets as n exterior cladding

Health and safety

Keep exposure to dust to a minimum. The silica dust in the cement can cause serious health problems. Wet cut the sheets or use a vacuum system attached to the cutting tool.

When cutting materials with power tools, use dust resistant safety goggles, at least a P2 filter respirator, and suitable clothing (such as overalls and industrial safety gloves). Always warn others before cutting so they can move away or put their own PPE on.

Vacuum up the dust rather than sweeping it up after cutting. Debris should be placed in bags, seal them, and disposed of them in an approved landfill.

Handling and storage

Carry the sheets on their edge to prevent any of the face surfaces being damaged.

Fibre cement sheets are best stored:

- flat and square to each other
- supported to avoid sagging
- placed in a dry area, protected from damp floors and clear of the ground
- protected from damage to edges, ends and surfaces.

Plaster board

Plaster board is a flat sheet made up of a heavy paper liner with a plaster inner core. It is available in sheets and is used to finish construction of walls and ceilings. A range of plaster boards are available, each with different properties that have been developed to provide protection against a number of construction problems.

Examples are:

- Wet areas, such as bathroom, kitchen and laundry. The plaster board contains special wax polymers to reduce water absorption.
- Noise reduction for quiet areas, such as bedrooms and studies. A double layer of plaster board on walls and ceiling helps reduce noise entry. A heavier, denser sound- reducing plaster board is also available.
- Hardwearing areas, for areas subject to high or rough use such, as stairwells, hallways, rumpus rooms, garage and children's bedrooms. This is a tougher plaster board containing a high density core.
- Fire resistant plaster board for use in high risk areas, such as the kitchen. It has a high-density core designed to withstand fire for up to four hours.

Plaster board is fixed to the wall frame or structure with adhesive and nails, or specially designed screws.

Health and safety

Keep exposure to dust to a minimum. Cut it in adequately ventilated areas.

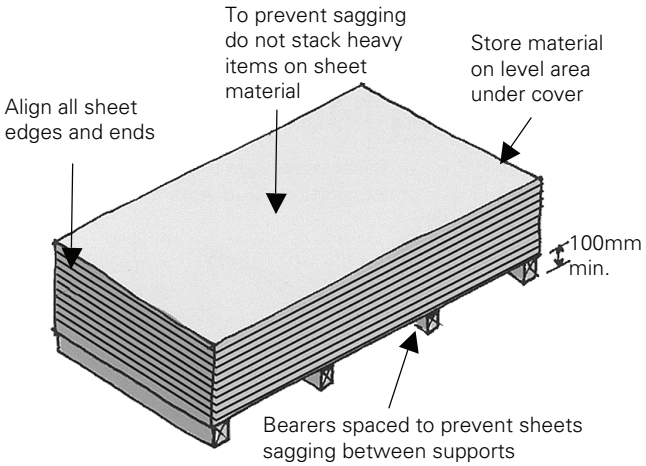
When cutting materials with power tools, use dust resistant safety goggles, a filter respirator and suitable clothing such as overalls and industrial safety gloves. As with fibre cement sheets, always warn others when dust is to be generated.

Use a fine water spray to suppress dust before sweeping. Debris should be placed in plastic bags and disposed of in an approved landfill.

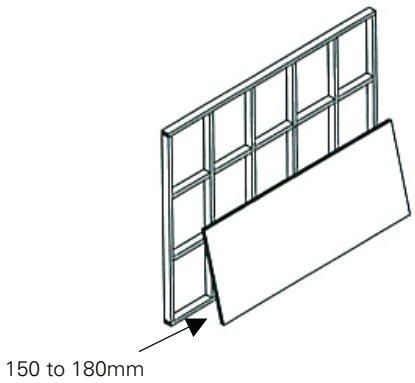
Handling and storage

Plaster board sheets should be stored on site using the following guidelines:

- flat and square to each other
- supported against sagging
- placed in a dry area, protected from damp floors and clear of the ground
- protected from damage to edges, ends and surfaces
- protected from moisture and direct sunlight penetration.



It's important to consider floor loadings on suspended floors, e.g. stacks of 10mm board should be limited to 30 sheets on suspended floors to minimise the risk of structural damage through point loading.



If floor storage space is unavailable, sheets may be leaned against a wall. A maximum of twenty 10mm or 13mm sheets can be stacked this way, or thirteen 16mm or 19mm sheets. To reduce the risk of toppling, place the first sheet 150 x 180mm from the bottom plate.

Manufactured boards

Manufactured boards include plywood, particle board, medium density fibreboard and hardboard.

Health and safety

Newly-manufactured board and freshly cut surfaces may release small concentrations of formaldehyde gas, which causes cancer. Concentrations of the gas increases if boards are stored in confined, poorly ventilated spaces.

The potential for the release of formaldehyde gas is greatly reduced when the boards are sealed with paint, varnish or other decorative surface finishes.

Use appropriate PPE when machining manufactured boards. This should include safety non-fogging goggles and a class P1 or P2 full face replaceable filter respirator. Wearing long sleeved overalls and comfortable work gloves will reduce the possibility of skin irritation when handling them.

When these boards are cut, drilled or sanded, dust will be given off. This dust may cause irritations to nose, throat and eyes. Splinters can cause skin infections. Components in these products may result in some people developing allergic dermatitis, resulting in itching and possible skin rash.

All work using these products should be carried out in such a way to minimise dust, gas and vapours.

In workshops, sawing, drilling, sanding etc. should be carried out with equipment fitted with exhaust extraction systems capable of removing dust, gas and vapours at the source. Portable power tools should only be used in well ventilated areas.

Storage and handling

Store manufactured boards in dry, well ventilated areas and well away from sources of heat, flame or sparks.

Off-cuts must not be burnt in barbeques, stoves or open fires in the home as toxic gases are produced. Dispose of off-cuts and general waste in approved landfill sites.

Dust from the boards should be cleaned up frequently. High concentrations of dust can be explosive.

Plywood

Plywood is made from thin sheets of wood veneers that are glued together under heat and pressure. The veneers are cross banded with the grain direction of each layer at right angles to the previous. This creates a very strong and stable wood-based material that provides equal strength in all directions. Plywood is also resistant to cracking, shrinkage, twisting and warping.

Plywood grades	
Plywood is produced in a range of grades, from A grade (top grade) to D grade.	The face grade of plywood is always the first designated:
A grade: high quality face, suitable for a clear finish.	**A – A** grade has two A (good) faces.
B grade: high quality, suitable for painting.	**A – D** grade has an A face and a D back.
C grade: non-appearance grade with a solid face – not meant to look attractive.	**B – B** grade has two B (good) faces.
D grade: low appearance grade with permitted defects.	**C – D** grade has a C face and a D back.
PG grade: non-structural – for packaging use – unsanded, rough appearance.	**D – D** grade has two D (rough) faces.

Plywood comes in a range of types and thicknesses. Common types of plywood are interior plywood, construction, exterior and marine plywood.

- **Interior plywood:** Suitable for interior use where there is full protection from the weather and high humidity. Commonly used for furniture construction. The glue used is often urea formaldehyde.
- **Construction plywood:** Manufactured in New Zealand from Radiata pine for general usage, such as cladding, flooring, trailers and general building. Available as untreated and treated (tanalised) for long term external exposure.
- **Exterior (marine bonded):** Plywoods in this category are generally of B – C or B – B/C – C grades and are waterproofed the same as marine plywood. There are no restrictions on the type of timber species used and core gaps are allowed.
- **Marine plywood BS 1088:** Some of the main criteria for this grade are that there are no core gaps in the lay-up, the face and back veneers must be of a high standard, and the timber used for the plywood is of an approved species, generally a durable one.

Particle board

Particle board is a low density fibre board. It is made from wood particles (such as wood chips, shavings, or saw dust) held together by a synthetic resin. Particle board is made up of larger pieces of wood than medium density fibreboard and hardboard. It is used for cabinet carcasses, vanities and cupboards, wall and ceiling linings and flooring.

Some advantages of using particle board are that it is:

- cheaper, denser, and more uniform than solid wood
- used when appearance and strength is less important than cost
- the lightest type of manufactured fibre boards.

Disadvantages of particle board is that:

- it will swell and distort if wet
- It will crumble and fall apart if waterlogged
- dressing edges is difficult so edges need to be covered or protected if exposed.

Medium density fibreboard

Medium density fibreboard (MDF) is a manufactured board that is formed by breaking wood down into fibres and combining them with wax and resin. The sheets are formed under high temperature and pressure. Similar manufacturing processes are used for making all types of fibreboard. MDF is heavier than particle board.

MDF is used extensively on interior applications, such as cabinet carcass construction, furniture, and wall linings.

Comparision MDF to natural timber	
MDF advantages	**MDF disadvantages**
Less expensive.	Heavier.
A wide range of surface finishes can be used including veneers, lacquer, paint and melteca.	Must be painted, transparent finishes are not useful.
Is consistent in its strength, and size (width, length).	When wet it swells and breaks.
Generally easier to work with.	Over time, will warp or expand if not sealed.
	Contains a substance called urea formaldehyde, which may cause irritation to the eyes and lungs when cutting and sanding.

Fixing MDF

A wide range of fastening methods are used to fix timber:

- **Screwing:** Use twinfast or particle board screws.
- **Gluing:** Most commercial brands of adhesives will provide excellent results. Refer to the manufacturer's specifications.
- **Nailing:** Use either annular grooved or spiral nails. Nails must be at least 25mm in from edge.
- **Stapling:** Pneumatic fastening of MDF is common.

Hardboard

Hardboard is a high density fibre board. It is similar to MDF but is much harder and denser. It can be used as a base for Formica and vinyl. It is used in a wide range of applications where a thin, hard wearing surface is required, such as in construction, furniture, appliances and automobiles. It is also used as the final layer in many skateboard ramps and half-pipes.

Tempered hardboard is made by adding oil under high temperature and pressure when the board is formed. This gives it more water resistance, hardness, rigidity and tensile strength.