Selecting timber

Learner Guide

Supporting:
FPICOT3247B:
Select timber
for forestry
operations

Version: July 2011

Acknowledgements, copyright and disclaimer

Acknowledgements

This learner guide was developed by McElvenny Ware Pty Ltd, trading as Workspace Training. It is a print-based adaptation of the ***Selecting timber*** e-learning unit developed by McElvenny Ware for the Australian Flexible Learning Framework in 2010.

The Selecting timber e-learning unit is available in two formats:

- as a free 'learning object' download from the Flexible Learning Toolbox Repository at: http://toolboxes.flexiblelearning.net.au/repository/index.htm
- as part of the Timber Plus Toolbox, a website resource covering nine units from the Forest and Forest Products Training Package (FPI05), available for purchase on a CD through Australian Training Products at: http://www.atpl.net.au/

For more information about the Timber Plus Toolbox, and other e-learning resources developed by McElvenny Ware, go to the Workspace Training website at: http://www.workspacetraining.com.au/

Copyright

Disclaimer

Table of contents

Introduction

Everyone who handles wood needs to understand its properties, and why it behaves in the way it does under particular conditions. Like every other building material, wood has its strengths and weaknesses. When it's used in ways that make the most of its strengths, wood is the most versatile and beautiful building material there is.

But it also has its limitations. That's why you need to have a sound knowledge of wood properties and good building practices to be able to make the most of its advantages and make up for its shortcomings. An understanding of wood properties also lets you advise customers on the best way to go about the jobs they want to do, how to store the timber once they receive it, and how to look after it once the job has been completed.

This unit covers the principles of wood technology, including growth characteristics, the properties of different species, things that destroy wood, and the process of drying.

This wood carver is using ancient skills that have been around for thousands of years. One of these skills is the ability to choose the right species of timber for the job, and then to work within its limitations and bring out the best in its strengths.

An understanding of wood properties will allow this carver to produce a sculpture that will be admired by future owners for generations to come.

Working through this unit

There are four sections in the unit *Selecting timber*:

1. Wood in a living tree
2. Characteristics of timber
3. Destroyers of wood
4. Seasoning of timber

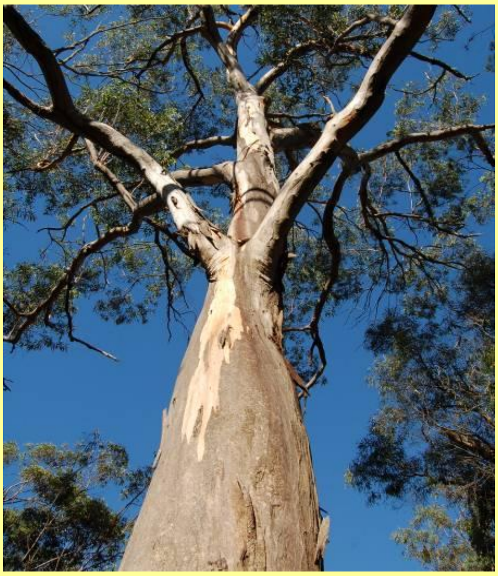
Each section begins with Your job, which introduces you to the topics covered. There are also several lesson pages in each section, and a Task at the end. Your trainer may ask you to submit the completed Tasks as part of your assessment evidence for the unit.

Section 1: Wood in a living tree

Your job

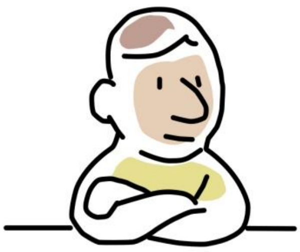
Most of the characteristics of wood are formed in the growing tree. So before we look at the properties and features of wood as they appear in a piece of timber, we need to understand how the wood cells form and why certain characteristics develop in response to particular events that the tree experiences during its lifetime.

In this section, we'll examine the different parts of a tree and the function they perform in helping the tree to grow and develop new wood cells. We'll also discuss the parts of the stem that are used in commercial timber production.



Trees are enormous solar powered production plants. As a rough average, for every one tonne of wood produced, a tree will take about 1000 tonnes of water from the soil and transport it through the roots, the stem, and up to the leaves.

Here's your job



1. Have a look at the Task for this section to preview the questions you'll need to answer at the end.
2. Work through each of the lessons for more detailed information on the concepts covered, and complete the learning activity at the end of each topic.
3. Complete the Task in your workbook

How trees grow

Trees grow by making food from the raw materials they extract from the soil and air. This process is called *photosynthesis*, because it uses the power of sunlight (‘photo’ meaning ‘light’) to process, or ‘synthesise’ the carbon dioxide from the air, water from soil and various other nutrients also absorbed from the soil.

Photosynthesis takes place in the leaves. Air enters the leaves through thousands of tiny pores, and is combined with water and chlorophyll to produce glucose, a type of sugar. The glucose is then carried in the sap stream to the growing parts of the tree. There it is converted into more complex carbohydrates, such as cellulose and starch.

Cellulose is the basic body-building material of plants, and the main component in wood. Food that is not used straight away is stored as starch.

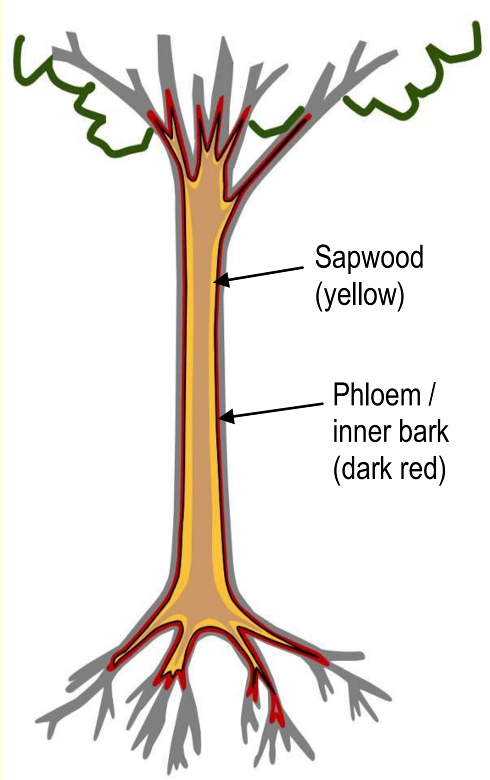
Growing Parts

Trees grow in three directions.

Up. The tree grows in height as its branch tips build new cells to make the branchlets longer. This is also where leaves and flowers are produced.

Down. The root tips are where roots grow in length. Most of the water and nutrients are absorbed by root hairs, which start a short distance behind the tips.

Outwards. The cambium layer makes the tree grow in girth. It is a thin layer in between the phloem and the sapwood. On the phloem side, it forms new inner bark, and on the sapwood side, it forms new wood tissue. We'll talk more about the role of the phloem in the next lesson: **The stem**.



Trees have a circulatory system for transporting water and food.

The upward system is in the *sapwood*. Water and nutrients from the soil are carried up through the sapwood to the leaves, where the process of photosynthesis is carried out.

The downward system is in the *phloem*, or inner bark. This is where the sugars manufactured in the leaves are carried back to all the growing parts of the tree.

Learning activity

Use your understanding of how trees grow to answer the following two questions.

If you have trouble answering the questions, you can do more research on the topic of growing trees at the Timber.org.au website, managed by the Forest and Wood Products Australia.

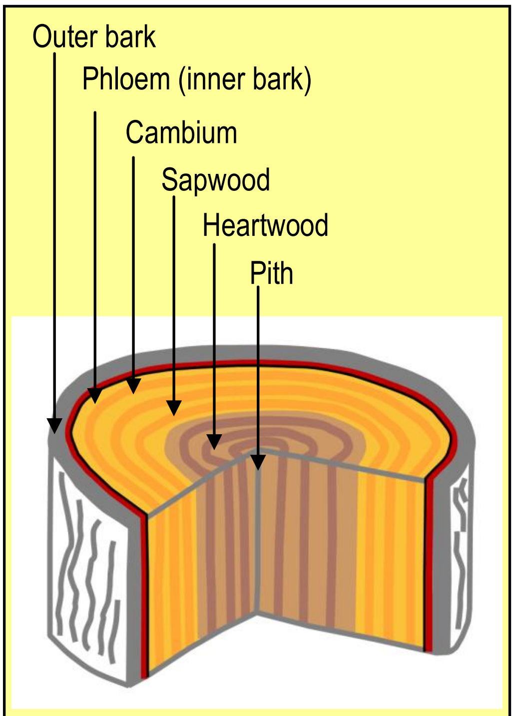
1. If you wanted to kill a tree by 'ring barking' it, all you would need to do is cut around the tree through the bark, deep enough to cut through the phloem.

   Why wouldn't you need to cut all the way through the sapwood?

2. Let's say a tree is 10 years old and has grown to a height of 4 metres. You come along and hammer a nail into the trunk at 2 metres above the ground. 10 years later the tree has grown another 4 metres, and is now 8 metres tall.

   How high will the nail be above ground level? Describe what the tree will have done to the nail.

The stem



Cross section of a tree's stem

In a growing tree, the stem comprises the following parts:

Outer Bark: This is the dead, corky, material that protects the stem from damage and stops the tree from drying out. As the tree grows in circumference, the bark gradually splits and falls off, and is replaced by new bark.

***Phloem*:** The phloem forms the inner bark. It carries the food made in the leaves to all of the growing parts of the tree – that is, the branches, roots and stem.

***Cambium*:** Underneath the phloem is a thin slimy layer of cambium. Its cells are constantly multiplying and forming new phloem tissue on the outside and new wood tissue on the inside. The cambium layer gradually moves outwards as the tree grows in girth.

***Sapwood*:** The sapwood carries water and nutrients upwards from the roots. It is made up of living cells and is often lighter in colour than the heartwood.

***Heartwood*:** As new sapwood is formed by the cambium, some of the inner sapwood becomes inactive and is converted to heartwood. The dead cells are used to store waste products from the growing tree, so the vessels become blocked and are no longer able to carry sap. This makes the heartwood turn a darker colour, and also makes it more durable in some species because the waste products are often toxic to attacking organisms.

***Pith*:** The small, soft, core near the centre is called the pith. It is the original tissue in the tree from its early growth as a sapling.

Converting the stem to timber

Commercial timber is taken from the sapwood and heartwood of the tree. In general, the band of sapwood is relatively wide in the softwood species and quite narrow in the hardwoods. In most species it's easy to tell the difference because the sapwood is lighter.

You'll often find that hardwood timber is re-sawn so that the sapwood is removed, because it is more prone to attack by certain insects. By contrast, some softwoods perform better when they're cut entirely from the sapwood, because it accepts preservative treatment chemicals more easily, and tends to dry more evenly.

In many species, such as cypress pine, the combination of sapwood and heartwood give the timber an appealing look because of the distinctive variation in colour between the two.

Learning activity

When you look at the end grain of a piece of timber, you can tell how close it was to the centre of the tree by looking at the radius of the growth rings. The tighter the curve, the closer it is to the pith.

There are times when it's important to know whether a board contains pith, or wood that is close to the pith. This is because the 'central heart region' tends to be lower in density and in some species is prone to particular defects. Hardwoods used for structural purposes have strict limitations on the amount of heart permitted in a board. Softwoods used structurally also have limitations, and there are grading rules that refer specifically to material within 50 mm of the centre of the tree. This means that if the growth rings have a radius of 50 mm or less, they need to be assessed separately from the rest of the board.

The best way to gauge the radius of growth rings is to scribe a circle onto a piece of Perspex and hold it up against the end of the board. If you don't have any Perspex or clear plastic, you can cut out a circle from a piece of paper or cardboard.

For this learning activity, make yourself a Perspex or paper 'growth ring gauge', using a 50 mm radius circle. Check out the curve of the growth rings on various pieces of timber, particularly softwoods, and see how closely they have been cut to the pith. Also see if you can identify where the heartwood changes to sapwood in pieces that contain both.

Take photos of the end sections of the pieces with your mobile phone or a digital camera. Write a short description of what each photo is showing, including the species and how close to the heart the piece is.

Task for Section 1: Wood in a living tree

An understanding of the tree that produces the wood you use is helpful to understanding the characteristics of that type of timber.

Your task is to choose one species that you work with and find out about the typical conditions the tree grows in. You can search the internet by typing the name of the tree into your search engine, or look up a reference book on the topic. You may even have brochures or information sheets in your workplace on that type of tree.

When you have completed your research, write down the following details:

1. Common name of the tree
2. Botanical name of the tree
3. Country (or countries) that the tree is harvested in to produce the timber you use
4. Whether the tree is typically harvested from a plantation or a native forest
5. The appearance of the tree – height, shape, characteristic features – you may provide a photo or describe the tree in words
6. Any other details about the typical climate, environmental conditions or growth characteristics of the tree – such as whether it is fast or slow growing, preferring hot, temperate or cold climates, and so on.

You will find a hard-copy template for this Task in your Workbook and an electronic version on the accompanying CD. Once you have filled in your answers, send your completed assignment to your trainer for marking.

Section 2: Characteristics of timber

Your job

There are many different species of timber, and each one has its own set of characteristics and properties. This is why some species perform better than others in particular circumstances – it all depends on how well their characteristics match the requirements of the end use.

For example:

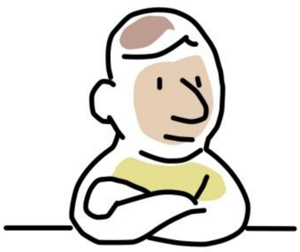
- flooring timbers need to be hard-wearing, and are often also selected on the basis of their colour and grain
- framing timbers need to have reliable strength characteristics and be relatively cheap
- cabinetmaking timbers must remain very stable over time and look appealing
- landscaping have to be highly durable and weather-resistant.

This section looks at the main characteristics that distinguish different species from each other. It also examines the botanical differences between softwoods and hardwoods, which are actually much more involved than simply determining whether the timber is 'soft' or 'hard'.

This barn uses different timbers for different purposes. The external cladding and window sashes are in western red cedar. External posts and structural members are treated pine. The wall, roof and floor framing are made of radiata pine. And the internal finishing timbers are in Tasmanian oak.

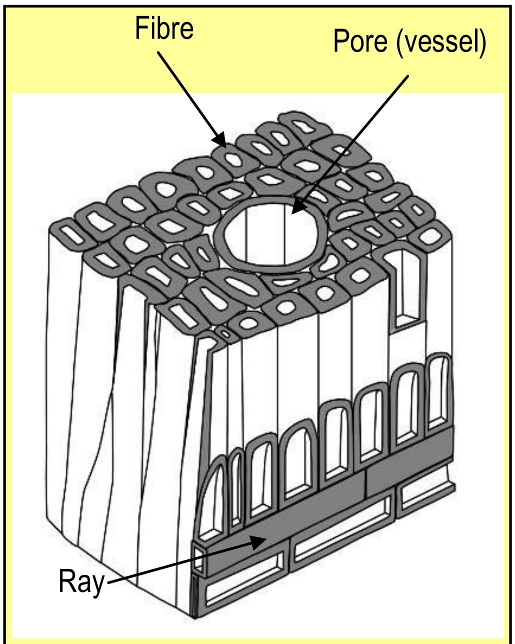
Because all of these timbers are being used to their best advantage, they should give many years of good service, without the need for any work other than normal upkeep.

Here's your job



1. Have a look at the Task for this section to preview the questions you'll need to answer at the end.
2. Work through each of the lessons for more detailed information on the concepts covered, and complete the learning activity at the end of each topic.
3. Complete the Task.

Structure of hardwood



A block of hardwood, magnified 250 times

Botanically speaking, hardwoods are *angiosperms*. This literally means 'covered seeds', and refers to the fact that the seeds are contained in gumnuts or flowers.

Most hardwoods have two main types of cells that run vertically. Sap is carried upwards in the *pores* (also called *vessels*), which join together one on top of another to form pipes. Strength is provided by *fibres*, which have thick cell walls and make up the bulk of the wood.

There are also cells called *rays*, which extend outwards from the pith towards the bark. Ray cells act as food storage areas in the stem. Although they are generally too small to see without a lens, some hardwood species have very large rays, giving timbers such as silky oak quite a distinctive appearance.

Cell walls are made mostly of *cellulose*, and are cemented together with a glue-like substance called *lignin*.

Learning activity

The term 'hardwood' often confuses people who don't know much about the structure of wood. This is because people naturally think that all hardwoods must be 'hard'. The fact is, they're not all hard. Some species, like balsa, are actually very soft.

The bottom line for classifying a timber as either a softwood or hardwood is whether or not it contains pores. In other words:

- *all timbers with pores are hardwoods*
- *all timbers without pores are softwoods.*

Some people think that it would be much easier to abolish the terms 'hardwood' and 'softwood' and simply refer to different species as either 'pored' or 'non-pored'. But that's never likely to happen, because these common terms are used by everyone, and it is true that often they are quite accurate in describing the hardness of the timber in question.

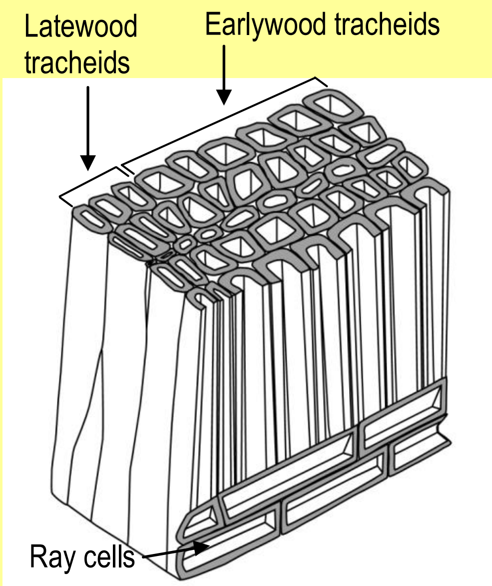
The learning activity for this lesson is combined with the next lesson. It's a test for you to see how well you can classify various commonly-used species as either hardwood or softwood. So you'll need to go to the next lesson first, before you do the activity.

Structure of softwood

Softwoods fall into the botanical category of *gymnosperms*, which means ‘uncovered seeds’. The seeds are generally found in cones, which open up to allow the seeds to blow away in the wind and germinate.

All commercially used softwoods come from *conifer* trees. They often grow in a conical shape and have needle-like leaves. Unlike deciduous trees that lose their leaves in autumn, most conifers are *evergreens*, meaning that they retain their leaves all year round.

Softwoods do not have pores in their cell structure. Instead, most of the woody tissue is made up of long narrow cells called *tracheids*, which transport the sap and also provide strength to the stem. Sap is also allowed to travel between the cells through *pits*, which are little valves in the cell walls.



A block of softwood, magnified 250 times

Like hardwoods, softwoods have ray cells which run from the centre of the tree towards the bark. Softwoods and hardwoods are also similar in their use of cellulose to build the cells’ walls, and lignin to cement the cells together. However, the proportion of lignin found in different species can vary a lot. There can also be a great deal of variation between species in the chemicals called *extractives* that are present in the cell cavities. These deposits often have an effect on the colour, smell and behaviour of particular species.

Learning activity

So far we’ve established that all hardwoods are ‘pored’ timbers and all softwoods are ‘non-pored’ timbers. It’s often the case that the cell walls in hardwood fibres are thicker than the walls in softwood trachieds, which tends to make the hardwoods heavier and stronger – and also ‘harder’ in the technical sense that they are more *impact resistant*. But there are many other hardwoods that do not have these properties.

Below is a collection of common species used in building and furniture making. See if you can classify each one correctly as either hardwood or softwood by writing an ‘H’ or ‘S’ next to it.

Ironbark	Hoop pine	Spotted gum	Western hemlock
Poplar	Blue Gum	Spruce pine fir	Oregon (Douglas fir)
Silky oak	Brush box	Balsa wood	Blackbutt
Tallowwood	Kauri pine	Rosewood	Cypress pine
Meranti	Beech	Australian cedar	Western red cedar
Alpine ash	Radiata pine	Baltic pine	Jarrah

Growth rings

At different times of the year, trees grow at different rates. In spring and early summer, when there's lots of water and sunlight and the temperature is increasing, trees grow fastest. The cells formed during this rapid growth phase tend to have thinner cell walls, with large cavities to conduct water. This area of fast-growing wood tissue is known as *earlywood*, or *springwood*, and appears as a wide growth ring in lighter coloured timber.

As summer progresses into autumn, the water supply becomes less available, days become shorter, and temperatures get cooler. As a result, the trees' growth begins to slow down and the cells develop thicker walls and thinner cavities. This shows up as much denser and narrower growth rings, called *latewood*, or *summerwood*.

In species where separate growth rings are formed reliably every year, they are also called *annual rings*. Although annual rings are common in the softwoods, and in some hardwoods that grow in colder regions, most Australian native hardwoods don't have annual rings, and the growth rings that they do have are often indistinct or merged with each other.

Radiata pine has very distinctive growth rings. It's easy to see exactly how many years' growth is represented in a piece simply by counting the rings. Some of the pieces in this pack of radiata show the pith as well, which is the first year's growth of the tree as a seedling.

Learning activity

Go out to the storage or yard area of your workplace to have a look at the end grain of different pieces of timber. If you have a variety of species, choose several different ones so you can make a comparison between them. If you've got logs as well as resawn timber, all the better.

Select at least half a dozen pieces, as different as possible from each other. If you've only got one species to choose from, try to select pieces from different grades or cross section sizes.

Record the following information for each piece:

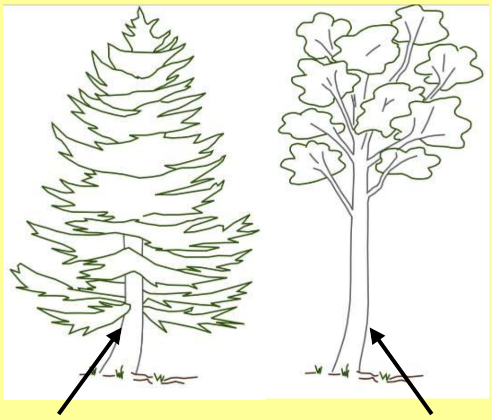
1. Species
2. Whether the species is a softwood or hardwood
3. Cross section size (or diameter, if it's a log)
4. Grade (such as the appearance grade or stress grade)
5. What the growth rings look like (including colour, how distinctive they are, etc)
6. What the distance is in millimetres between the bands of latewood. Measure this with a tape measure held at right angles to the growth rings.

7. If you can count the annual rings, how many years' growth are present in the piece
8. Any other notable features about the growth rings (such as whether they get closer together the further away from the heart they are).

Take digital photos of the pieces and include them with your descriptions.

Reaction wood

In order to grow quickly, trees need to absorb as much sunlight as they can. To do this, they usually try to grow vertically. Sometimes, however, they may grow to one side to get as much sunlight as possible. In other cases, trees may have to withstand continual stresses on one side due to high winds that tend blow from the same direction.



Compression wood in a softwood tree

Tension wood in a hardwood tree

Wood that forms to counteract these stresses is known as *reaction wood*. This is also a normal characteristic in branches, because of the angles they grow at, and it is therefore a feature of knots in timber. Reaction wood is weaker than normal wood and tends to shrink more when it dries.

In softwoods, reaction wood occurs on the underside of a lean. Because the wood tissue is under pressure from above, it is called *compression wood*. It tends to be darker than the surrounding wood due to a higher lignin content, and often produces a fuzzy surface finish when it's cut or sanded.

In hardwoods, reaction wood forms on the upper side of a lean, and tries to pull the crown of the tree towards an upward position. The wood formed is therefore under tension, and so is termed *tension wood*. It, too, tends to give a fuzzy finish when it's cut or sanded, and it also tends to collapse when it dries.

Learning activity

See if you can answer the following two questions correctly by thinking about the effect that reaction wood might have on a piece of timber.

1. If a piece of timber is part normal wood and part compression wood, is it likely to warp as it dries?

2. Would a large tree branch be able to be resawn into a good piece of timber if it was big enough to get a reasonable length and cross section out of it?

Durability

The durability of a species of timber is its life expectancy when exposed to organisms that might attack it. Durability ratings always refer to the heartwood of timber, as the sapwood is considered non-durable in every species. This is because sapwood is full of the sugars and starches that the tree uses for food, and is therefore a good food source for any invading insects and fungi.

The natural durability ratings of a wide range of species are set out in Australian Standard (AS) 5604. Each species is given two durability ratings:

1. probable in-ground life expectancy
2. probable above-ground life expectancy.

The two ratings are required because timber used above the ground outdoors will generally last a lot longer than timber in direct contact with the ground. This is because ground contact allows moisture to be constantly absorbed through the fibres, making the wood more susceptible to fungal decay and attack by particular insects, especially termites.

Some species, like the brush box in this parquetry floor, are highly resistant to particular organisms but not so much to others.

Although brush box is very resistant to termites, it has much less resistance to decay. It's therefore given a durability class of '3', which is a compromise between the upper and lower levels of its natural durability.

Durability classes

There are four classes of durability, ranging from 1 to 4. Below is a summary of the durability classes published in AS 5604.

Durability classes and life expectancy		
Durability Class	Probable in-ground life expectancy (in years)	Probable above-ground life expectancy (in years)
1	Greater than 25	Greater than 40
2	15 to 25	15 to 40
3	5 to 15	7 to 15
4	0 to 5	0 to 7

Durability ratings of various species

Showing the natural durability of the untreated heartwood of each species.

Common name	Botanical name	Durability class	
		In-ground	Above ground
Ash, Alpine	Eucalyptus delegatensis	4	3
Ash, Crow's	Flindersia australis	1	1
Ash, Mountain	Eucalyptus regnans	4	3
Ash, Silvertop	Eucalyptus sieberi	3	2
Belian	Eusideroxylon zwageri	1	1
Blackbutt	Eucalyptus pilularis	2	1
Blackbutt, New England	Eucalyptus andrewsii Eucalyptus campanulata	2	2
Bloodwood, Red	Corymbia gummifera	1	1
Box, Brush	Lophostemon confertus	3	3
Box, Grey	Eucalyptus microcarpa Eucalyptus moluccana	1	1
Brownbarrel	Eucalyptus fastigata	4	3
Cedar, Red (Australian)	Toona australis	2	-
Cedar, Western Red	Thuja plicata	3	2
Cypress, White	Callitris glaucophylla	2	1
Fir, Douglas (Oregon)	Pseudotsuga menziesii	4	4
Gum, Blue, Southern	Eucalyptus globulus	3	2
Gum, Blue, Sydney	Eucalyptus saligna	3	2
Gum, Grey	Eucalyptus propinqua Eucalyptus punctata	1	1
Gum, Manna	Eucalyptus viminalis	4	3
Gum, Mountain	Eucalyptus dalrympleana	4	3
Gum, Red, Forest	Eucalyptus blakelyi	1	1

	Eucalyptus tereticornis		
Gum, Red, River	Eucalyptus camaldulensis	2	1
Gum, Rose (Flooded)	Eucalyptus grandis	3	2
Gum, Shining	Eucalyptus nitens	4	3
Gum, Spotted	Corymbia maculate Corymbia citriodora	2	1
Hemlock, Western	Tsuga heterophylla	4	4
Ironbark, Grey	Eucalyptus drepanophylla Eucalyptus paniculata Eucalyptus siderophloia	1	1
Ironbark, Red	Eucalyptus sideroxylon	1	1
Ironbark, Red, Broad-leaved	Eucalyptus fibrosa	1	1
Ironbark, Red, Narrow-leaved	Eucalyptus crebra	1	1
Jarrah	Eucalyptus marginata	2	2
Karri	Eucalyptus diversicolor	3	2
Kempas	Koompassia malaccensis	3	-
Mahogany, Red	Eucalyptus pellita Eucalyptus resinifera	2	1
Mahogany, White	Eucalyptus acmenoides Eucalyptus tenuipes Eucalyptus umbra	1	1
Meranti, Dark-red	Shorea spp.	4	3
Meranti, Light-red	Shorea spp.	4	4
Merbau (Kwila)	Intsia bijuga	3	1
Messmate	Eucalyptus obliqua	3	3
Pine, Bunya	Araucaria bidwillii	4	4
Pine, Caribbean	Pinus caribaea	4	4
Pine, Hoop	Araucaria cunninghamii	4	4
Pine, Radiata	Pinus radiata	4	4
Pine, Slash	Pinus elliottii	4	4

Stringybark, Silvertop	Eucalyptus laevopinea	3	3
Stringybark, White	Eucalyptus eugenioides	3	2
Stringybark, Yellow	Eucalyptus muelleriana	3	2
Tallowwood	Eucalyptus microcorys	1	1
Turpentine	Syncarpia glomulifera	2	1
Woollybutt	Eucalyptus longifolia	1	1

Treated timber

Some species of timber have a cell structure that makes them very suitable for treating with preservative chemicals. Radiata pine is the best example of a naturally non-durable timber that can be used just about anywhere once it's been treated. Different chemicals are used to cater for different conditions and risks that the timber might be exposed to.

Learning activity

See if you can answer the following questions by thinking about the exposure risks and durability ratings of the different timber species mentioned. Make sure you use the Durability table (above) to check the rating of each species before you decide on your answer.

1. You have just bought an old flat-top ute with a timber tray, and you're planning to do it up. You have a choice between two species of hardwood tongue and groove flooring – karri and alpine ash. Which one are you going to choose? Why?

2. A customer has asked you whether they should use oregon rough sawn boards as outside cladding on a barn they are building. These boards are recycled and much cheaper than the equivalent in western red cedar. What will your advice be? Why?

3. You have a lot of left-over untreated radiata pine framing timber. You're thinking of using it to build your front driveway gates. Is this a good idea? Why or why not?

4. The house you're renovating has had termites in it. You start to pull up the floor in one room and discover that although the hardwood joists have been severely attacked, the floor boards themselves are virtually untouched. You know the floor boards are a softwood. What species of softwood are they likely to be? Why?

Density

Density is an expression of the mass (or weight) of timber in a given volume. It is measured in terms of kilograms per cubic metre (kg/m^3).

In general, the denser a species is, the stronger it is. This is because the biggest factor that affects density is the thickness of the cell walls in the wood fibre. However, there are other components that also contribute to the mass, including water, resins and oils, so just because a piece of wood feels heavy, it doesn't always mean that it's also very strong.

Green density (GD) refers to the density of wood at the time the living tree is felled. Because this mass includes the water contained in the cells' cavities and walls, it's not a reliable measure of a timber's strength.

Air dry density (ADD) refers to the density at 12% moisture content. This allows a more direct comparison between species, since the moisture content remains constant. Thus, a change in density is a good indicator of the amount of woody substance in a given volume, which is what gives a piece of timber its strength.

Basic density (BD) is a measure of the amount of actual wood substance present, without any water at all. It is calculated by finding the 'oven-dry mass' and dividing it by the 'green volume'. Because it reflects the thickness of the fibre walls and the number of fibres present, it is an important factor in the manufacture of paper from wood pulp. For more information on these terms see the next section – *Seasoning of Timber*.

This piece of kiln dried radiata pine is about half the weight of the same sized piece in kiln dried ironbark. And even if it was straight grained and free of any defects, the radiata would still have much less strength than the ironbark. Why? Because the cell walls are much thinner.

But it's worth remembering that the relative weight of a piece isn't a perfect indicator of its strength. Dry cypress pine is heavier than radiata but also weaker, because the extra density is made up of tannins and oils.

Note that the density figures shown in reference tables are always averages for a given species. The density of actual pieces in a particular species can vary greatly, depending on how fast that tree grew, the maturity of the wood in the tree and the conditions of growth.

See the density table on the following pages for the densities a range of timbers.

Density ratings

Showing the Green density (GD) and Air-dried density (ADD) of each species in kilograms per cubic metre. ADD figures are based on a moisture content of 12%.

Common name	Botanical name	GD	ADD
Ash, Alpine	Eucalyptus delegatensis	1050	650
Ash, Crow's	Flindersia australis	1050	950
Ash, Mountain	Eucalyptus regnans	1050	650
Ash, Silvertop	Eucalyptus sieberi	1100	850
Belian	Eusideroxylon zwageri	1300	1000
Blackbutt	Eucalyptus pilularis	1150	900
Blackbutt, New England	Eucalyptus andrewsii Eucalyptus campanulata	1150	850
Bloodwood, Red	Corymbia gummifera	1150	900
Box, Brush	Lophostemon confertus	1100	900
Box, Grey	Eucalyptus microcarpa Eucalyptus moluccana	1170	1120
Brownbarrel	Eucalyptus fastigata	1100	750
Cedar, Red (Australian)	Toona australis	640	420
Cedar, Western Red	Thuja plicata		350
Cypress, White	Callitris glaucophylla	850	700
Fir, Douglas (Oregon)	Pseudotsuga menziesii	710	550
Gum, Blue, Southern	Eucalyptus globulus	1150	1000
Gum, Blue, Sydney	Eucalyptus saligna	1100	850
Gum, Grey	Eucalyptus propinqua Eucalyptus punctata	1250	1050
Gum, Manna	Eucalyptus viminalis	1100	800
Gum, Mountain	Eucalyptus dalrympleana	1100	700
Gum, Red, Forest	Eucalyptus blakelyi	1150	1000

	Eucalyptus tereticornis		
Gum, Red, River	Eucalyptus camaldulensis	1150	900
Gum, Rose (Flooded)	Eucalyptus grandis	1100	750
Gum, Shining	Eucalyptus nitens	1100	700
Gum, Spotted	Corymbia maculate Corymbia citriodora	1200	1100
Hemlock, Western	Tsuga heterophylla	800	500
Ironbark, Grey	Eucalyptus drepanophylla Eucalyptus paniculata Eucalyptus siderophloia	1250	1100
Ironbark, Red	Eucalyptus sideroxylon	1200	1100
Ironbark, Red, Broad-leaved	Eucalyptus fibrosa	1210	1140
Ironbark, Red, Narrow-leaved	Eucalyptus crebra	1160	1090
Jarrah	Eucalyptus marginata	1100	800
Karri	Eucalyptus diversicolor	1150	900
Kempas	Koompassia malaccensis	1000	850
Mahogany, Red	Eucalyptus pellita Eucalyptus resinifera	1200	950
Mahogany, White	Eucalyptus acmenoides Eucalyptus tenuipes Eucalyptus umbra	1150	1000
Meranti, Dark-red	Shorea spp.	1100	650
Meranti, Light-red	Shorea spp.		400
Merbau (Kwila)	Intsia bijuga	1150	850
Messmate	Eucalyptus obliqua	1100	750
Pine, Bunya	Araucaria bidwillii	720	460
Pine, Caribbean	Pinus caribaea	990	500
Pine, Hoop	Araucaria cunninghamii	800	550
Pine, Radiata	Pinus radiata	800	550
Pine, Slash	Pinus elliottii	850	650

Stringybark, Silvertop	Eucalyptus laevopinea	1030	860
Stringybark, White	Eucalyptus eugenioides	1100	1000
Stringybark, Yellow	Eucalyptus muelleriana	1150	900
Tallowwood	Eucalyptus microcorys	1200	1000
Turpentine	Syncarpia glomulifera	1050	950
Woollybutt	Eucalyptus longifolia	1120	1050

Learning activity

Below is a list of timber species. Use the Density table above to find the GD and ADD figures for each of these species and write down your answers. Look closely at the difference between the two figures for each species, and see if you can find a pattern developing as you go down the list.

What is the pattern?

What do you think this says about the cells that make up the different species, and their ability to hold water?

Timber species:

Grey box

Turpentine

Sydney blue gum

Jarrah

Alpine ash

Dark red meranti

Caribbean pine

Task for Section 2: Characteristics of timber

Choose four species of timber that you work with. (If you don't handle four different species in your workplace, you may go to a local timber yard, or even include furniture or other timber items you have access to.)

For each species:

1. Record the following details:
   (a) Standard trade name
   (b) Botanical name
   (c) Hardwood or softwood – that is, whether the timber is 'pored' or 'non-pored'
   (d) Description of growth rings – colour, how distinctive they are, distance between the rings (if they are well marked)
   (e) In-ground durability class – natural durability of the heartwood when in ground contact (and not preservative treated)
   (f) Above ground durability class – natural durability of the heartwood when outdoors and above ground (and not preservative treated)
   (g) Green density – density in kilograms per cubic metre when green
   (h) Air dried density – density in kilograms per cubic metre when dried to 12% moisture content
2. Take one or more photos, showing the grain and other features that are characteristic of the species. You may submit digital or print photos. If you don't have access to a camera, you should do your own line drawings of the most distinctive features of the species, and describe in words what you've drawn.

You will find a hard-copy template for this Task in your Workbook and an electronic version on the accompanying CD. Once you have filled in your answers, send your completed assignment to your trainer for marking.

Section 3: Organisms that destroy wood

Your job

There are lots of organisms that like to eat wood. Trees have a certain amount of natural resistance to some of these wood destroying organisms, particularly when they're growing in their natural habitat.

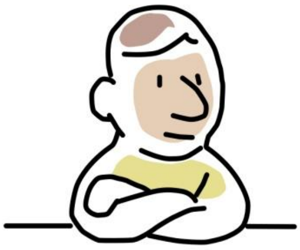
But once the tree has been harvested and re-sawn into timber products, it is very important that the wood's natural weaknesses are recognised, and that it is used appropriately and properly protected from future attack.

In this section, we'll look at the most common biological destroyers of wood.

This power pole has got its fair share of problems. Termites have completely ravaged the sapwood all the way up to the top. But now that the outer layers are falling off and exposing the termites' runways, they have cleared out and the fungal decay is getting in.

There are ways of avoiding these problems, such as by identifying the forms of attack that might occur in a particular location, and then choosing the right species of timber and the most appropriate form of treatment.

Here's your job



1. Have a look at the Task for this section to preview the questions you'll need to answer at the end.
2. Work through each of the lessons for more detailed information on the concepts covered, and complete the learning activity at the end of each topic.
3. Complete the Task.

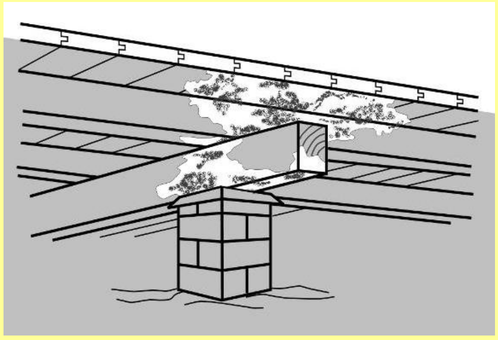
Fungi

Unlike plants that use photosynthesis to manufacture their own food, fungi need to find a food supply that has already been produced for them. For particular species of fungi, their food source is wood tissue.

Fungal attack in timber begins when the tiny spores land on a surface that allows them to germinate. Conditions that favour germination include:

- a suitable moisture content, generally at least 20%
- an adequate oxygen supply
- a temperature range to suit their life cycle
- enough nutrients to support their growth.

Fungi that attack timber can be classified into two main groups:



Some homes with raised timber floors and poor subfloor ventilation provide perfect conditions for decay fungi. This example shows what can happen when the shower leaks, or water is able to seep through the floor some other way into the subfloor area.

It's worth noting that conditions favourable to decay fungi are also favourable to termites.

1. Wood destroying fungi

Wood destroying fungi are also called *decay* fungi, because they feed on the cell walls and cause the wood fibres to break up and crumble away. The three main types are:

- **brown rot**
- **white rot**
- **soft rot**

Brown rot

Brown rot feeds mainly on the lighter coloured cellulose and leaves the darker lignin intact, giving the surface a dark brown look with deep cracks running lengthwise and across the area. Because the decayed timber usually feels dry and flaky, it's often called 'dry rot'. But this term is a bit misleading, considering that for the attack to occur in the first place, the moisture content of the timber must be at least 20%.

Most forms of brown rot attack softwoods and the lighter hardwoods.

White rot

White rot attacks the cellulose and lignin, leaving a whitish deposit behind.

The decayed timber doesn't crumble as much as in brown rot, and there is more likely to be pockets of decayed wood surrounded by sound areas.

Soft rot

Soft rot is different in appearance from brown and white rot, and less common. This form of decay tends to make longitudinal cavities in the cell walls, particularly in hardwoods.

2. Wood disfiguring fungi

These fungi generally have no effect on the strength of the timber, because they don't attack the cell walls. But they can still be a serious problem in appearance grades due to the discolouration they cause. The two types of fungi in this category are:

- **sap-stain fungi**
- **surface moulds.**

Sap stain fungi

These fungi feed on the sugars and starches inside the wood rays, rather than on the cells walls This is why they're not a problem in structural timber – they aren't breaking down the wood fibres.

In softwoods, the most common form is *blue stain*, which is a particular problem in sawlogs left lying around in warm humid conditions.

Surface moulds

Surface moulds produce a powdery or woolly growth on the surface of the timber. They often leave behind a green, brown or orange discolouration.

Some surface moulds even grow on preservative treated timber, particularly when the timber is covered by dust, which helps to trap moisture.

Learning activity

You don’t have to look very far to see examples of fungal attack in timber. If the company you work for has an outside area where discarded timber is stored, you should find plenty of fungal decay and surface moulds. If you work in a forest area, you’ll be surrounded by many different types of fungi. Even at home or out in the street, there will be examples of fungal attack in pieces of timber lying on the ground, particularly if they are partially covered by soil.

See how many different types of fungi you can find. Take photos of them with your mobile phone or camera, and note the conditions you found the timber under, and if possible, the species of timber that was attacked.

If you have trouble identifying the type of fungi you’ve found, ask your trainer or your workplace supervisor for advice.

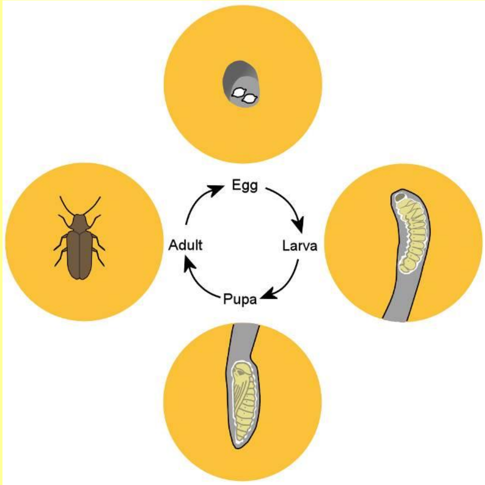
This activity will help you to complete the Task for this section.

Borers

Borers are beetles, which at some stage of their development bore into wood for food or shelter.

Since some borers can have a serious effect on the strength of timber, there are specific building regulations designed to reduce the chance of particular types of attack. The regulations vary from one region to another, and also from state to state, depending on the likelihood of attack occurring in that area.

Below are the most common borers affecting timber that's used commercially.



This diagram shows the typical life cycle of a borer. In most cases, the major damage is done by the larva, or grub, when it tunnels through the timber to access food.

Generally speaking, the only damage borers cause as adult beetles is when they drill an exit hole through to the surface so they can fly away and look for a mate.

Lyctid borers

Lyctid borers are also called 'powder post beetles'. They attack only the sapwood of particular hardwood species. The female beetles lay their eggs beneath the surface of the wood by inserting their ovipositor into the pores. If the pores of a particular species are too small for the ovipositor, then that species is immune from attack. Because softwoods don't contain pores, they are all immune from attack.

Anobium borers

The most common type of anobium borer in Australia is the 'furniture beetle'. This beetle prefers damp, humid conditions and is a particular problem in old furniture, It's also known to attack baltic pine flooring in houses with poor sub-floor ventilation. In Queensland, the 'hoop pine borer', also from the anobium family, is sometimes found in hoop and kauri pine.

Ambrosia borers

Ambrosia borers are more commonly known as 'pin hole borers'. The female bores a long straight hole into the wood to deposit its eggs, and then coats the walls of the hole with ambrosia fungi to provide a food source for the larvae when they hatch. This is why the holes generally have a characteristic blackish stain around them when the timber is sawn. Pin hole borers only attack tress and freshly felled logs, since the ambrosia fungi need a high moisture content to survive.

Longicorn borers

Longicorns are a forest problem, rather than a dry timber problem. They generally attack hardwoods, and drill oval shaped holes up to 10 mm in diameter, although sometimes the holes can be larger. Longicorns include the witchetty grub varieties.

More information

If you're interested in knowing more about the different types of borers and what their damage looks like, you'll find a lot of information on the web. A good starting point is the CSIRO website – www.csiro.au

Learning activity

Like fungi, there are examples of borer attack everywhere. It’s common to see pin hole borer holes in meranti boards, and even if you don’t stock meranti in your workplace, you’ll often see the pin holes in skirtings, architraves and door jambs in buildings. Longicorn borer holes are commonplace in sawn hardwood, and again, if you don’t handle hardwood at work, you’ll still see borer holes in hardwood paling fences, and of course, in living trees. If you live in an older home, you may have your very own examples of lyctid or anobium damage.

See how many different types of borer holes you can find. Take photos of them with your mobile phone or camera. You may be able to cut off samples to show your trainer or supervisor if you have trouble identifying the type of borer and species of timber that was attacked.

This activity will help you to complete the Task for this section.

Termites

Although there are about 300 species of termites in Australia, only a dozen or so are a problem for timber in buildings. Most termites feed on grass and roots, as well as living trees and decaying wood. Termite colonies can contain up to several million members, so when they find a good source of food they're capable of causing a lot of destruction.

Some species of termites have a whitish skin colour, which is why they're often called 'white ants'. However, they aren't really ants, and are actually biologically closer to cockroaches.

The termites that cause the most damage to building timbers are the subterranean species. They typically have their nest in a tree or partially decayed piece of wood buried in the ground. From here, they tunnel through the soil looking for food. Because they need to be protected from daylight and the external atmosphere, they always leave a veneer of wood on the outside of a piece. This is why infested timber often has a drummy or papery sound when it's tapped.

In a building, termites sometimes build mud-covered shelter tubes over the foundations and up piers or walls to get to the sub-floor timbers. Although ant caps aren't able to stop their progress, the caps do make the tubes more visible when an inspection is carried out.

Termites at work. This piece of wood was lying face down on the ground, and when it was turned over the termites were exposed. Typical of most termites, their skin is moist and unpigmented, and they are blind, so once they're exposed to daylight they won't last very long.

If you find live termites in a building, the best thing to do is cover over the runway, and then call the pest controller. You need to disturb them as little as possible, so that the pest controller can work with the active runway to get access to the nest, which may be some distance away.

Apart from the subterranean termites, there are some dry wood species which can infest building timbers without needing direct ground contact. However, they are only found in certain tropical and sub-tropical coastal regions.

More information

There are many commercial pest control companies with excellent websites that provide lots of information and photos on termite behaviour, preventative measures and good building practices. Just type 'termites' into your search engine to have a look at what's available.

Learning activity

Termite activity is easy to find in bushland areas, because that's where they're performing the role that nature intended for them – breaking down wood fibre and returning the nutrients to the soil. If you roll over logs or look for hollow trees, you'll see plenty of evidence of termite activity.

If you're lucky, you'll find live termites at work. But remember, they like to be completely sheltered from light and the outside air, so you'll generally need to peel back the bark or the top layer of timber to see them. If you're really lucky, or in another sense, really unlucky, you'll have your own examples of termite damage at home.

Take photos of the termite activity and the conditions under which the wood was attacked.

This activity will help you to complete the Task for this section.

Task for Section 3: Organisms that destroy wood

Find four different examples of damage done by wood-destroying organisms in your own workplace. The types of damage you come across will depend on the sort of work you do and the environment you work in.

For instance, if you work in the forest, you’re likely to see many live examples of wood-destroying insects and fungi. If you work in a timber yard, you’ll see the results of the insects’ efforts, such as pinhole borer holes in pacific maple, longicorn borer holes in hardwood and termite damage in hardwood sleepers. And if you’re working on a jobsite, or even around your home, you’re sure to see samples of fungal decay, either in wood left lying in the mud or timber used in old post and rail fences, fascia boards, pergolas or various other exposed applications.

For each example you come across, try to identify the species of organism and the conditions under which it was found.

You will find a hard-copy template for this Task in your Workbook and an electronic version on the accompanying CD. Once you have filled in your answers, send your completed assignment to your trainer for marking.

Section 4: Seasoning of timber

Your job

For particular applications, seasoned timber has many advantages over green timber. Some species improve so much that you rarely see them used in their green state. Radiata pine, for instance, when dry is used just about everywhere – house framing, furniture, wall panelling, treated decking, and so on. But in its unseasoned state it is limited to landscaping material and a few specific uses like packing cases and battens.

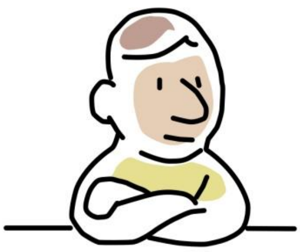
These hardwood boards have been 'stripped out' so they can air dry. When the moisture content has dropped to the required level, they will be put into the kiln and dried under controlled conditions. Then they will be ready for milling to flooring profiles.

The same applies to many other species. Now that Australian hardwoods are increasingly being used in value-added applications, such as flooring, joinery, furniture and high-grade beams, the timber used in these products is always kiln dried before use.

There are some end uses that still call for unseasoned timber. These include sawn hardwood for bearers, joists and fencing material, and sawn oregon for beams and framing. But for most applications that require a high quality appearance grade as well as stability and strength, the process of seasoning is well worth the extra effort involved.

In this section, we'll discuss the process of seasoning and the various effects it has on the properties of wood.

Here's your job



1. Have a look at the Task for this section to preview the questions you'll need to answer at the end.
2. Work through each of the lessons for more detailed information on the concepts covered, and complete the learning activity at the end of each topic.
3. Complete the Task.

Measuring moisture content

The moisture content of wood is usually expressed as a percentage. This simply represents the weight of the water contained in the piece, compared with the weight of the woody substance itself. That is:

$$\text{Moisture Content (MC) \%} = \frac{\text{weight of water}}{\text{weight of woody substance}} \times 100$$

The fraction part gives you the proportion of water to wood fibre, and multiplying it by 100 converts the fraction into a percentage.

For example:

A piece of softwood weighs 12 kg in its green state. The woody substance in the piece weighs 8 kg. What is the moisture content of the piece?

$$\text{MC} = \frac{12 - 8}{8} \times 100$$

$$= \frac{4}{8} \times 100$$

$$= \frac{1}{2} \times 100$$

$$= 50\%$$

This hand-held moisture meter measures the electrical resistance between the two probes. The more moisture there is in a piece of wood, the less electrical resistance there will be.

The meter uses this information to calculate the moisture content of the piece.

In other words, the water in the piece weighs half as much as the wood fibres themselves.

Moisture and density

The amount of moisture that a piece of wood can hold depends on its density, or the amount of solid wood fibre packed into a given volume. For example, balsa is a very lightweight, porous timber which can hold up to 4 times its own weight in water. That is, in the growing tree it can have a moisture content of up to 400%. On the other hand, ironbark has so much woody tissue with thick cell walls that there's very little space left to hold water. Its green MC can be as low as 40%.

Methods of measurement

There are two main ways of measuring moisture content in timber. The simplest and most efficient method is to use a moisture meter. A more accurate process, used by kiln operators and others who need precise measurements, is the ‘oven dry’ method.

Measuring moisture content with a moisture meter

A moisture meter works by passing a current between two probes pushed into the wood, and measuring the electrical resistance between them. The principle is that dry wood is a good insulator and water is a good conductor, so the more moisture there is in the piece, the less resistance there will be to the electric current.

However, there are some factors that can make this reading inaccurate. These include:

- the air temperature at the time
- the species of timber being measured
- the presence of any chemicals, such as preservative treatments.

You can improve the accuracy of the readings by looking up conversion tables which make corrections for these variables. But you need to remember that the result is only ever an approximation, probably within plus or minus 2%.

Measuring moisture content using the ‘oven dry’ method

The first step in using the oven dry method is to cut a small test piece from the timber, making sure that you cut it away from the end so that it isn’t overly dry and unrepresentative of the rest of the piece. Then weigh the test piece on a set of scales. This will give you the total weight of the woody material and water combined.

Put the test piece in an oven at just over 100^0 C until all of the moisture has evaporated out of the cell cavities and walls. This process may take up to 24 hours.

Once the test piece has reached a moisture content of zero, weigh it again to find out what the woody material weighs is without any water in it. Then use the normal formula to calculate the moisture content of the original piece of timber.

That is:

$$MC = \frac{\text{weight of water}}{\text{weight of woody substance}} \times 100$$

$$= \frac{\text{original weight} - \text{oven dry weight}}{\text{oven dry weight}} \times 100$$

For example:

A test piece is cut from a hardwood board. In its green state the test piece weighs 100 g. When it's oven dry it weighs 80 g. What is the moisture content of the original board?

$$MC = \frac{100 - 80}{80} \times 100$$

$$= \frac{20}{80} \times 100$$

$$= \frac{1}{4} \times 100$$

$$= 25\%$$

Learning activity

See how you go with your own calculations using the moisture content formula.

You have been given a piece of oregon and asked to find its moisture content. You cut a test piece and find that it weighs 60 g. After you have oven dried it to zero MC, you find that it weighs 50 g.

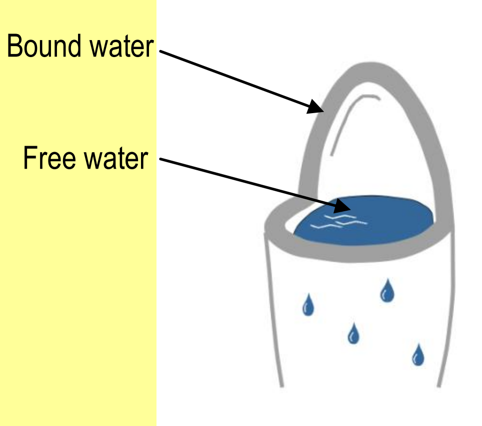
1. How much does the moisture weigh in the test piece (in grams)?
2. What is the moisture content of the original piece?

The drying process

When a log is freshly cut, the fibres contain a great deal of water, both in the cell cavities and the cell walls. Since the moisture in the cavities is free to evaporate once a cell has been cut, it is termed *free water*.

As the wood dries, the free moisture continues to evaporate until the cavity nearly dries out, after which the water bound up in the cell walls begins to evaporate. This point is called *fibre saturation point,* because the fibres are still saturated, even though the cell cavities are now almost dry. On average, this occurs in most species at around 30% MC.

Until fibre saturation point is reached, the biggest change in the timber is that it gets progressively lighter as the free moisture is lost. After fibre saturation point, however, the cell walls begin to shrink and get stiffer. This is the process of *seasoning*.



This cell has been cut open to show the *free water* in the cell cavity, and the *bound water* in the cell wall.

Bound water is sometimes called *combined water*, because the moisture is ‘bound up’, or ‘combined’ with the fibres in the cell wall.

Equilibrium moisture content

Wood is *hygroscopic* by nature. That is, it absorbs and releases moisture according to the environment. Eventually, all timber exposed to the atmosphere will reach *equilibrium moisture content* (EMC) – that is, a moisture content in balance with the surrounding air. So you can never ‘air dry’ a piece of wood to zero MC, because the air itself always contains some moisture.

EMC in most indoor coastal situations is between 10% and 15%. Once timber is seasoned, its MC will only change as the humidity, or moisture content of the air, changes. In very dry areas, such as inland, it may dry down to 6 or 7%.

Methods of drying

The two main methods used to season timber are air drying and kiln drying.

Air drying

Timber being air dried needs to be clear of the ground, with individual pieces separated by strips and spaced apart, so that the air can pass over all surfaces. This enables the air to pick up the surface moisture and then drop down to the ground to discharge the droplets.

The biggest problem with air drying is that it can take a long time for the timber to reach EMC. Hardwoods typically take a year or more per 25 mm (one inch) of thickness to reach EMC. That is, a two inch thick board would take at least two years to dry to a seasoned state. So although it avoids the expense of using a kiln, it can be uneconomical in other ways, tying up stock and yard space for months or even years.

Kiln drying

Kilns have mechanical ventilation systems and heat and humidity controls to allow much faster drying under controlled conditions. For slow-drying hardwoods, it's often more economical to air dry them to fibre saturation point, and then kiln dry them to EMC. This means that getting the moisture from 30% down to 12% can be reduced to several days.

However, the higher temperatures in kilns do tend to create drying stresses, so it's common at the end of drying to give the timber stack a high humidity treatment to relieve any internal stresses. Some hardwoods are also pre-steamed before the drying process begins to reduce the problem of 'collapse', where the cell walls buckle under the stress of drying.

For plantation softwoods, such as radiata pine, high temperature kilns are generally used. Unlike conventional kilns, which use temperatures of well below 100^{o} C, radiata can be dried at up to 160^{o}, which allows small-section sizes to be dried in a matter of hours. The high temperatures also soften the wood constituents, particularly the lignin that bonds the fibres together, helping to overcome the problems of twist, spring and bow during the drying process.

Advantages of seasoning

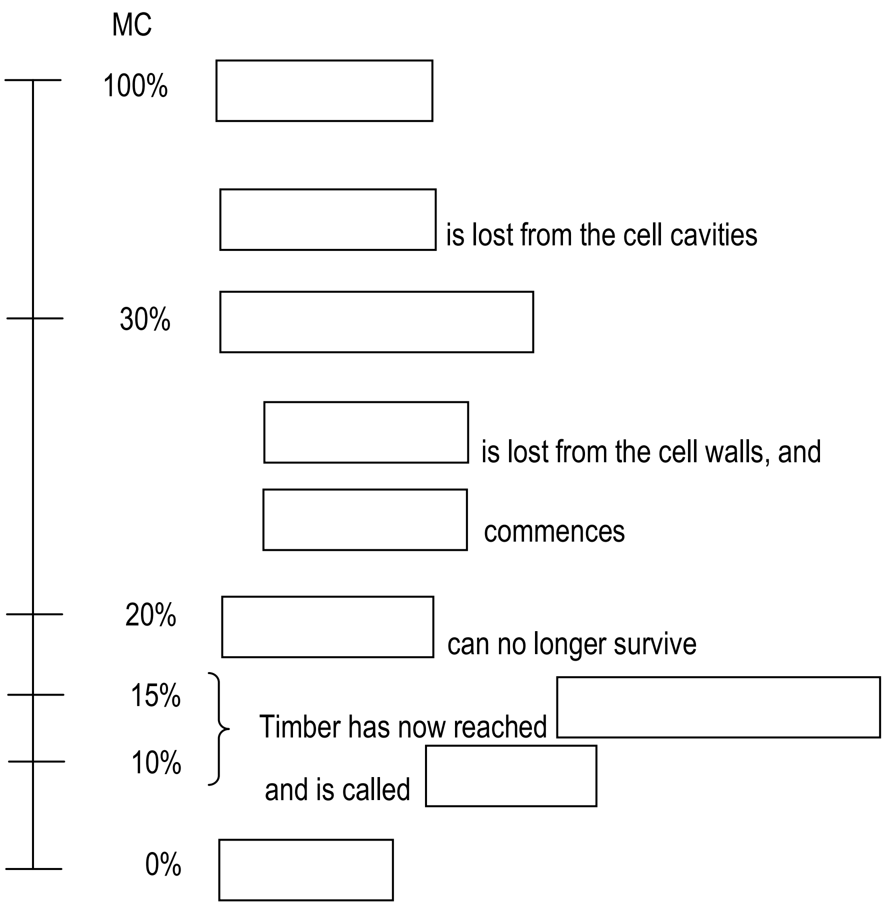
Here's a brief summary of some of the advantages of seasoning.

- *strength* increases, as the cells shrink and become stiffer, and the lignin hardens
- *weight* decreases, because the moisture content is less
- *durability* improves, because there is more resistance to the organisms that draw food and moisture from the timber, such as decay fungi
- *gluing* is more reliable, as some adhesives require dry material to form a good bond
- *stability* improves, which means the timber will stay straighter in storage and will need less restraint in the finished structure
- *joinery* work can be done, without the risk of the timber shrinking away from tight joints.

Learning activity

Below is a chart showing a range of moisture content levels. See if you can fill in the significant points correctly by writing the terms into their correct position. You'll need to draw on some of the information you've learned in earlier sections of this unit to complete all of these points.

Significant points in the drying of timber



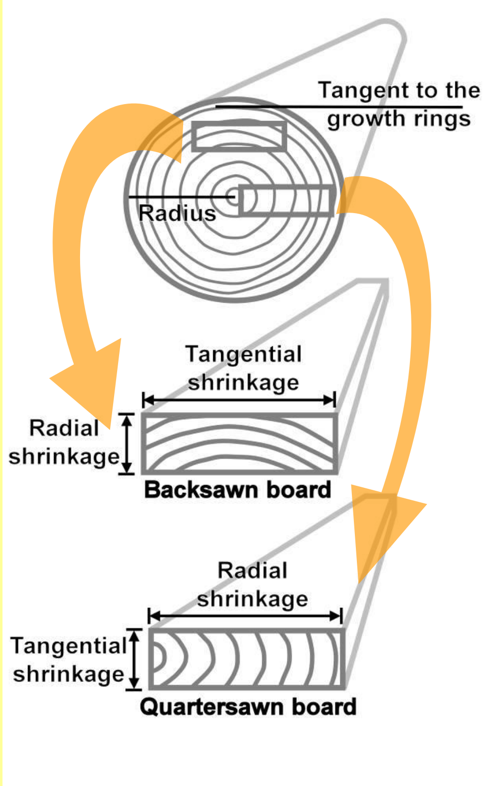
Shrinkage and movement

When the moisture content in timber drops below fibre saturation point, it begins to shrink as the combined water in the cell walls starts to evaporate.

However, the width, thickness and length of a piece of timber will tend to shrink at different rates, depending on how it is cut. A backsawn board, for example, will shrink about twice as much across its face as a quartersawn board. On the other hand, its edge will only about shrink half as much.

This is because *tangential shrinkage* – shrinkage at a tangent to the growth rings – is roughly double that of *radial shrinkage* – shrinkage towards the centre of the log. The main reason for this is that the ray cells, which run radially from the centre towards the bark, have a restraining effect on movement in their length.

The *longitudinal shrinkage* – shrinkage along the length of the piece – is minimal, as long as the piece has straight grain, because the wood fibres hardly shrink at all along their length.



This diagram shows the difference between a backsawn board and quartersawn board in terms of its orientation to the log.

The backsawn board has its ‘face’ (the wide surface) cut at a tangent to the growth rings. So the ‘edge’ (the narrow surface) cuts across the growth rings like a radius.

The quartersawn board has the growth rings running the other way around – its face is cut radially and the edge is tangential.

The difference in growth ring orientation will mean a difference in shrinkage rates between these two boards.

Warping

Because shrinkage occurs at right angles to the direction of the grain, a variation in grain angle to the edges of a piece can result in warping as it dries. Timber often contains sloping grain, such as a deviation of grain around a knot, or ‘curly’ or ‘spiral’ grain throughout the piece.

Brush box characteristically contains a large proportion of curly grain as a natural feature, which can make it a tricky timber to keep straight while it’s drying. Timber containing spiral grain, where the direction follows a corkscrew shape, will tend to twist.

Twist can also occur if the piece dries unevenly, especially if one edge is exposed to the sun. Uneven drying can also cause bow, spring and cupping, because the cells are shrinking at different rates in different parts of the board.

Checking and collapse

The outside, or *case*, of a piece of timber always dries faster than the core. This introduces tension stresses in the surface of the piece because of the different rates in shrinkage, which can cause the surface to crack. These cracks are called *surface checks*.

Sometimes in the final stages of drying, when the core shrinks, the internal tension stress can pull the timber case inwards, closing up the surface checks, but inducing internal checks. This is called *honeycombing*.

In some species, the drying cells can buckle due to an excessive change in pressure while the free water is evaporating. This is called *collapse*. The effect is like sucking on a straw and holding your finger over the other end, making the straw flatten. Timbers that collapse can be reconditioned by steaming the cells and restoring their shape.

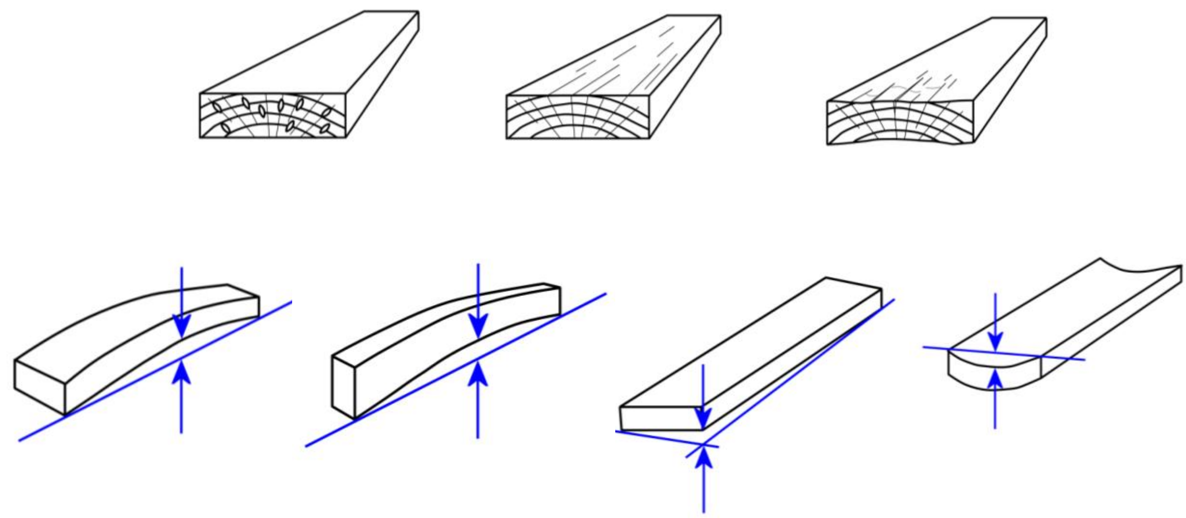
Learning activity

You may already be familiar with some of the technical terms used in this lesson to describe the movement that can occur when a board dries. Others you may have heard of, but not been sure exactly what they meant.

This exercise is designed to help you double check your understanding of these terms. See if you can match up the drawings and terms below by writing the correct term under each board shown below.

Terms:

Spring Bow Surface checks Twist Cup Honeycombing Collapse



Task for Section 4: Seasoning of timber

Choose two seasoned timber products that you handle at work. They may be dressed boards, framing, mouldings, flooring, window joinery, beams, or any other item used in building or furniture making.

For each of the products:

1. Describe its features, by specifying the size, species and typical end uses.

2. Describe some of the problems that can occur due to moisture content changes while the product is in storage or in transit. These may include distortions in the board, surface checking or splitting.

   List the possible causes of these problems. These may include hot winds, exposure to the sun or rain, or uneven swelling or shrinkage.

   Describe the methods you use, or should use, to minimise the problems while the product is in storage or transit.

3. Describe some of the problems that might occur in the timber due to moisture content changes after installation in the final structure.

   List the possible causes of these problems. These may include excessive sunlight, leaking plumbing, or the breakdown of moisture barriers or protective coatings.

   Describe the finishing processes and maintenance procedures that should be followed to minimise these problems over the life of the building or structure.

You are encouraged to take digital photos to accompany your answers and submit them either as JPG files or in hard copy. For each photo, provide a brief description of what it is showing and which question it relates to.

You will find a hard-copy template for this Task in your Workbook and an electronic version on the accompanying CD. Once you have filled in your answers, send your completed assignment to your trainer for marking.

Glossary

Term	Definition
Arris	Intersection of the face and edge of a piece of wood.
Backsawn timber	Timber that is sawn so that the growth rings are inclined at less than 45 degrees to the wide face.
Bound moisture	Moisture which is bound up in the cell walls of wood fibres.
Bow	Curve in the lengthwise direction of a board causing the wide face to move away from a flat plane.
Cambium	Thin layer of tissue between the bark and sapwood that subdivides to form new wood and bark cells.
Check	Separation of fibres along the grain – generally caused by drying stresses – but not extending from one surface to another.
Collapse	Flattening of cells during the drying process, caused by the cell walls buckling under the changing pressure.
Compression	Force that tends to crush the wood fibres.
Cup	Deviation across the surface of a board that causes it to curve away from a flat plane.
Decay	Decomposition of wood, caused by fungi.
Density	Mass, or weight, of a block of wood, expressed in kilograms per cubic metre.
Durability	Natural resistance of timber to fungi and insects.
Earlywood	Less dense part of a growth ring – also called 'springwood'.
Equilibrium moisture content (EMC)	Moisture content in balance with the surrounding atmosphere.

Fibre saturation point	Point in seasoning where the cell cavities are free from water but cell walls are still saturated with bound water – generally about 25-30% moisture content.
Free moisture	Moisture which is present in the cell cavities of wood.
Grain	General direction of the wood fibres.
Green	Unseasoned timber.
Growth rings	Rings on the cross section of a trunk marking cycles of growth.
Gum vein	A ribbon of gum between growth rings.
Gum	A natural substance, also called kino, produced in trees as a result of fire or mechanical damage.
Hardwood	Timber classified botanically as 'angiosperms', with a cell structure characterised by 'pores' (also called 'vessels').
Heartwood	Wood containing dead cells that make up the centre part of the tree, and often filled with phenolic compounds, gums and resins.
Honeycombing	Drying defect that results in internal cavities.
Kiln	Enclosure used for drying timber under controlled conditions.
Knot	Cross section of a branch that has been surrounded by wood tissue in the stem.
Latewood	Denser wood in a growth ring – also called 'summerwood'.
Moisture content (MC)	Weight of moisture contained in a piece of timber – expressed as a percentage of the weight of the woody substance.
Pith	Soft core in the centre of a tree trunk or branch.
Quartersawn timber	Timber that is sawn so that the growth rings are inclined at more than 45 degrees to the wide face.
Sapwood	Outer layers of wood in the growing tree containing living cells.
Seasoned timber	Timber that has been dried to within a specific moisture content range – generally 10% to 15%, unless otherwise specified.

Shake	Separation of wood fibres caused by stresses in the standing tree or during the felling or processing stages – but not caused by drying stresses.
Shrinkage	Reduction in dimension or volume that occurs when the moisture content is reduced below fibre saturation point.
Softwood	Timber classified botanically as 'gymnosperms', with a cell structure that does not contain pores.
Split	Defect that occurs when stresses cause the wood fibres to separate and form cracks that run from one surface to another.
Spring	Lengthwise curve of the edge of a piece of timber, not affecting the face.
Tension	Force that tends to pull wood fibres away from each other.
Unseasoned timber	Timber that has not been seasoned.
Wane	Presence of the original underbark surface, with or without bark, on the face or edge of a board.
Want	Absence of wood, other than wane, from the face or edge of a board.
Warp	Variation from a true surface, including bow, cup and twist, generally caused by irregular seasoning.