Hardwood visual stress grading

Measurement and assessment of characteristics

This document is downloadable from the BuildingLearning website, on the *Visual stress grading techniques* page in *Section 5: Structural Timber Grading*. It is designed to accompany the *Hardwood Grading Card*, also downloadable from the same webpage, which lists the specific limitations that apply to the various F grades. All information is based on *AS 2082-2007: Timber - Hardwood - Visually stress-graded for structural purposes.* There is a separate document for softwood visual stress grading.

Knots and holes

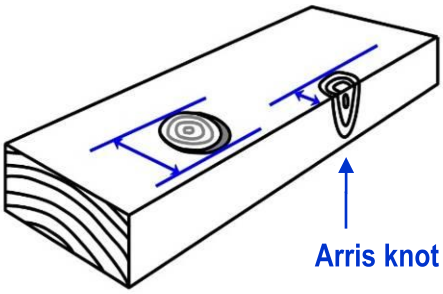
Knots

A knot is a section of the branch of the tree, cut through when the timber has been re-sawn. For the purposes of grading structural hardwoods, it doesn't matter whether the knot is tight or loose, sound or unsound, intergrown into the surrounding fibres, round or oval, single or in clusters, or even a hole – as long as the hole is not caused by insects.

This is because it is assumed that a knot contributes no strength to the timber, so it makes no difference what the knot or void actually looks like.

There are two basic types of knots in structural hardwoods:

- **arris knots**, which cut the arris between a face and edge of the piece
- **knots other than arris knots**, which include everything else.



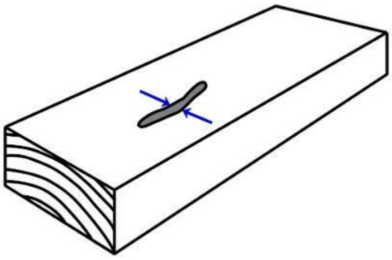
An arris knot is measured on its smallest side, by measuring from the arris to the outside point of the knot at right angles to the arris. All other knots are measured across the face or edge of the piece, at right angles to the arris. If the knot appears on more than one face or edge, the largest dimension should be measured.

The maximum permissible knot sizes are shown below, together with their equivalent percentages, to make it easier to compare the different sizes to each other.

Knots – maximum width across the face or edge of the board			
Structural No. 1	**Structural No. 2**	**Structural No. 3**	**Structural No. 4**
1/7 (14%)	1/4 (25%)	1/3 (33%)	3/8 (38%)

Borer holes

If the hole has been caused by a borer, its size is measured at its widest point across the hole – that is, at right angles to longitudinal direction of the hole.



Gum veins and overgrowths

Gum occurs in growing trees as a defence mechanism against damage to the wood tissue from fire, insects and mechanical abrasion. Gum veins, gum pockets and overgrowths of injury are graded according to the effect they have on the strength of the piece. Below are the main characteristics and methods of measurement of these types of defects.

Gum veins

A gum vein is **tight** when it is bridged by wood tissue at close intervals along its length. A gum vein is **loose** when the gum completely separates the wood fibres on either side, forming a crack or split in the piece of wood.

Tight gum veins do not have a serious effect on the strength of a piece, and there is no limitation on them in any grade other than Structural No. 1.

Loose gum veins are the equivalent of a check or split, depending on their depth, and so are graded in the same way as checks or splits.

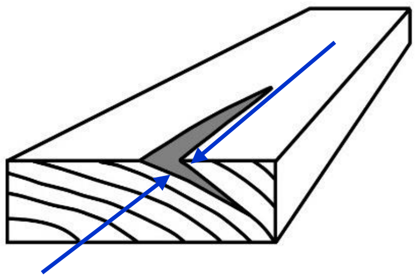
Included bark has a similar effect to a loose gum vein. It occurs when strands of bark are trapped between the wood fibres, and the same grading rules apply as for loose gum veins.

Gum pockets and overgrowths

Gum pockets, latex pockets and resin pockets are formed in the growing tree as a result of damage.

Overgrowths of injury are areas of dead or damaged wood that have been overgrown by new wood, and are often combined with gum or resin.

All of these characteristics are assessed in the same way, because they all have the same effect on the strength of the timber.



The **width** is measured radially – that is, towards the centre of the tree. The **length** is measured parallel to the length of the piece.

Sloping grain

Timber is strongest when the grain is straight and runs parallel to the length of the board. The more it deviates from straight and parallel, the weaker it becomes. This is why you need to look out for **sloping grain** when you're grading structural timber.

Note that it is normal for the grain to deviate around knots. As long as this is limited to **local deviation**, it doesn't need to be separately assessed, because the grading rules governing knot size will have already allowed for it. The same applies to variations in the grain as it curves along a piece – if the deviation is no more than half the width of the piece, you can call it **localised**.

But where there is a general slope of grain it needs to be considered as a separate characteristic, because it will have a strength-reducing effect on the piece.

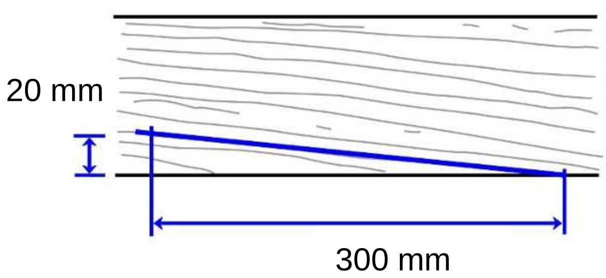
If you're in doubt about what the grain is doing in a particular area of the board, you can find out using one of the following methods:

- **look for surface checks** – these always follow the grain, because they're caused by the fibres pulling away from each other as the timber dries
- **split a small portion** of wood off the board, or prise a slither away from the surface – again, you will be separating the fibres, so you will know exactly where the grain is going
- **use a scribe** – this is also called a 'sloping grain detector', and it is basically a gramophone needle on the end of a rod that tracks along the grain as you pull the detector down the board.

Calculating slope

The slope of grain is expressed as a ratio of **rise to run**.

For example, if the grain rises 1 cm over a run of 10 cm, the slope will be 1 in 10.



The best way to measure slope is to find the worst section in the piece, measure 300 mm along the length, and find out what the rise is over that distance.

The example on the previous page shows a rise of 20 mm to a run of 300 mm. Therefore:

$$20 \text{ mm in } 300 \text{ mm} = \frac{20}{20} \text{ in } \frac{300}{20} = 1 \text{ in } 15$$

Distortions in the board

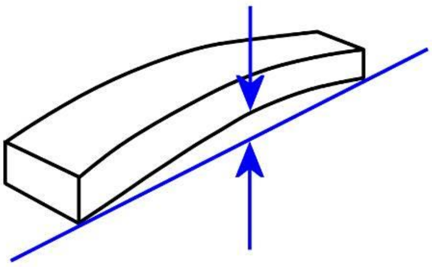
It's not uncommon for there to be a small amount of distortion in a board, especially if it dries unevenly or has a grain direction that moves around along its length.

Small amounts of deviation can be pulled out of a board when it's fixed into position in the structure. But the worse the deviation is, the harder it is to work with.

There are tables in AS 2082 specifying the maximum amount of bow, spring, twist and cup allowed in a board. Once the distortion exceeds that level, it is rejected from the grade.

Bow

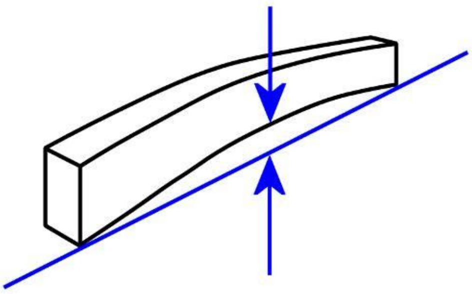
Bow is a curve along the length of a board that causes the **face** (wide surface) to move away from a flat plane. That is, if the board is laid down flat with the bow facing up, the board will rise in the middle.



To measure bow, stretch a string line from one end of the board to the other, and measure the point of maximum deviation between the string line and the edge of the board.

Spring

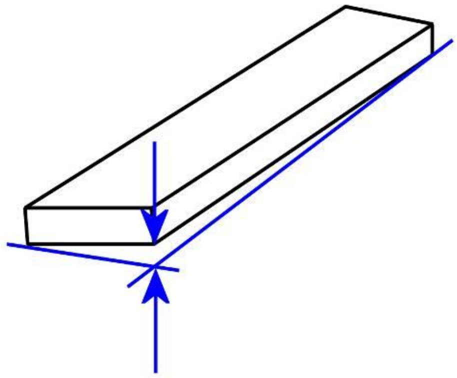
Spring is a curve along the length of a board that causes the **edge** (narrow surface) to deviate from a straight line. That is, if the board is turned on its edge, it will rise in the middle.



To measure spring, stretch a string line from one end of the board to the other, and measure the point of maximum deviation between the string line and the face of the board.

Twist

Twist is a curl in the board that causes one end to move away from a **flat plane**. That is, if the board is laid down flat on a bench, only three of the corners will be touching the bench.

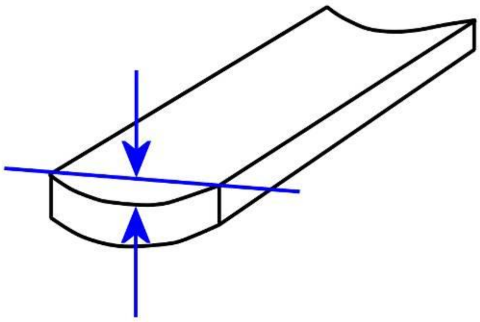


Lay the board down flat on a perfectly flat base. Measure the distance between the base and the raised corner of the board while holding the rule at right angles to the base.

Note that a concrete floor is generally not flat enough to take an accurate measurement. In workplaces where there are no steel bench tops or other reliably flat surfaces, the only way to assess twist is to sight along the board and estimate the deviation.

Cup

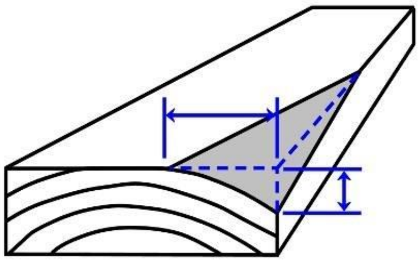
Cup is a curve **across the face** of a board. That is, if the board is laid flat with the cup facing up, the board will rock from side to side.



Hold a straight edge across the concave face of the board, and measure the distance between the straight edge and the face at its worst point.

Want and wane

Want and wane are both measured in terms of how much of the face or edge of the piece is missing.



Wane is the appearance of the underbark surface of the log, which causes some of the arris to be missing on the piece. Sometimes the surface is smooth, but other times there is still bark attached.

Want is the absence of wood from the surface or arris when it's caused by anything other than wane. For example, forklift damage or abrasions from chains can break off the edge of a piece and result in want.

Using the 'want or wane' rule for other defects

If a characteristic or combination of characteristics fall entirely within the allowance made for want and wane, you can accept the defect without having to assess its size separately. The only exception to this rule is when you are assessing enclosed termite galleries, because they could extend much further into the piece than is visible.

Termite galleries

Open termite galleries are fully visible, without any burrows that disappear into the timber. They are assessed as for want or wane.

Closed termite galleries are not fully visible. They are not permitted in any grade.

Primary rot

Primary rot is caused by **fungal decay** that occurred in the living tree. The maximum depth allowed is 3 mm, and there are also limitations on its surface area.

Basically, if you can't find the bottom of the decay by scraping away the top 3 mm of the surface material, you must reject the piece.

Lyctid susceptible sapwood

Some hardwoods are susceptible to attack by lyctid borers.

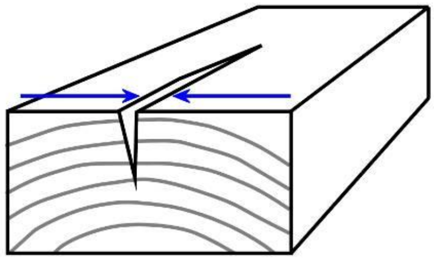
The borers only attack the sapwood of these hardwoods, so if the piece does not contain sapwood, it will be safe.

If the piece does contain sapwood, it must either be treated with an approved preservative (such as CCA) or contain no more than a prescribed amount of sapwood around its perimeter, as specified in the relevant Timber Marketing Act. In NSW, this amount is 50% maximum with on any face or edge, or 25% of the total perimeter of the piece.

Checks

Checks generally form as the result of drying stresses, where the wood fibres pull away from each other because different areas are shrinking at different rates.

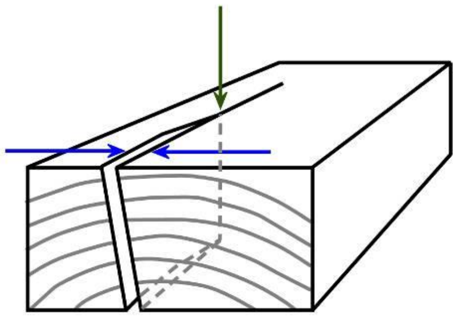
They always run lengthwise with the grain, and their depth is radial to the growth rings – that is, towards the centre of the tree.



The **width** of a check is measured at right angles to the direction its length is going in. The **length** of a check is measured parallel to the length of the board.

It's important to remember that a check does not go from one surface to another. When this happens, it is called a **split**.

Splits



A split is a lengthwise separation of fibres that runs from one surface to another surface. It sometimes occurs when a drying check gets so bad that it goes right through the piece, and is particularly common on the ends of a board.

Note that where a separation of fibres begins as a **split** and then disappears on one surface, it becomes a **check** from that point on.

In the diagram above, the dotted line indicates where the split stops on the underside. This is marked by the green arrow on the top face, so from that point the crack turns back into a surface check.

Splits in the body of the piece are not permitted at all. On the ends they are called **end splits**, and are permitted with different limitation depending on the grade.

Shakes

There are several types of shakes, such as heart shakes, ring shakes and cross shakes. What they all have in common is that they are not caused by drying problems, but are the result of internal stresses in the standing tree or in the log during felling or conversion to sawn timber.

Like splits, they have a serious effect on the strength of a piece, and in most instances are not permitted at all if they run from one surface to another surface unless they are able to be treated as end splits.

Heart shakes

Heart shakes radiate from the pith, often in the form of a star pattern. Note that these shakes are permitted in particular species, as outlined below under the heading: *Material containing heart*.

Ring shakes

Ring shakes follow the growth rings. They are sometimes called ‘cup shakes’ or ‘water shakes’, because in the standing tree they can collect water.

They are also sometimes referred to as ‘shell shakes’, which is why timber is described as ‘shelly’ when it peels away due to the separation of fibres across the ring shake.

Cross shakes

Cross shakes are also called ‘cross fractures’, ‘stress shakes’ or ‘compression failures’.

They do not follow the direction of the fibres, but run across the grain.

They can be hard to see, and sometimes show up as tiny fractures or crinkles running across the grain.

Material containing heart

The central heart region of hardwood trees often contains problems that affect the strength of the wood fibres.

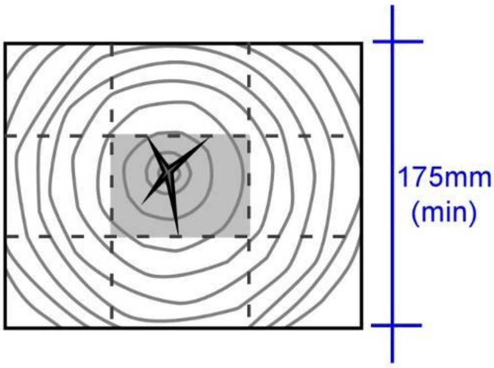
Note that the *Australian Standard Timber Glossary* (AS 4491) defines **heart** as timber that is within a **50 mm radius** of the pith.

In other words, '**heart'** is not the same as **heartwood**, which is simply all the inactive wood cells in the growing tree that have died after being filled with waste deposits.

Problems in heart material include:

- **fungal attack** – from decay fungi that have entered the stem through the roots or cavities in the base of the tree
- **brittle heart** – unusually brittle material caused by growth stresses in the tree or by fungal attack
- **compression failures** – fractures across the grain caused by the weight of the tree, or internal stresses due to snow or wind.

In general, **heart** and **heart shakes** are not permitted at all in timber that is less than 175 mm thick (that is, where the smaller dimension is less than 175 mm).



In large-sectioned beam sizes where the thickness is at least 175 mm, they are permitted, but only in the **central third** of the piece, as shown in the diagram at right.

However, an exception is made in AS 2082 for the following species, where heart and heart shakes are allowed in any cross-sectional size, as long as the area of heart material falls within the limitations specified for the individual grades:

- Blackbutt
- Grey box
- Red forest gum
- Spotted gum
- Ironbark – grey, red, red mixed, red broad leaved, red narrow leaved.

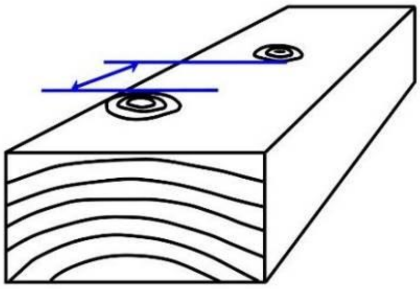
All of the above species have in-grade test results that have confirmed particular F grades for pieces containing heart and heart shakes within the specified limits.

Combinations of characteristics

When particular defects occur close to each other, their combined effect on the strength of the board tends to be worse than their individual effects.

The combination rule is that if two characteristics occur within a length that is twice the width of the board, then their strength-reducing effects have to be added together.

The only exception to this rule is **distortions** in the board – bow, spring, twist and cup – which must be assessed separately.

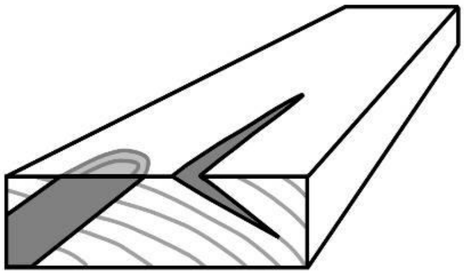


For example, if the board in the diagram at right is 100 x 50, the combination rule will apply to all defects within 200 mm of each other.

The **distance** between the defects is measured parallel to the length of the piece, between lines that run at right angles, marking out the closest points of the defects to each other.

Remember that characteristics can appear on any surface, so you have to turn each piece while you're grading to see which ones fall within the combination rule.

Characteristics of different types



If the two characteristics are of the same type, you can simply add their sizes together.

But if they are of different types, such as a knot and a gum pocket, then you have to work out each characteristic's proportionate size relative to the maximum allowed for that defect, and add the two proportions together.

For example, if a knot was just over half the maximum size allowed in that grade, and a gum pocket was just over half the maximum size allowed in that grade, then in combination they would exceed the total amount permitted, and the board would not make that grade. In this particular case, you could drop it down to the next Structural grade, unless it didn't meet the limitations for that grade either.