Softwood visual stress grading

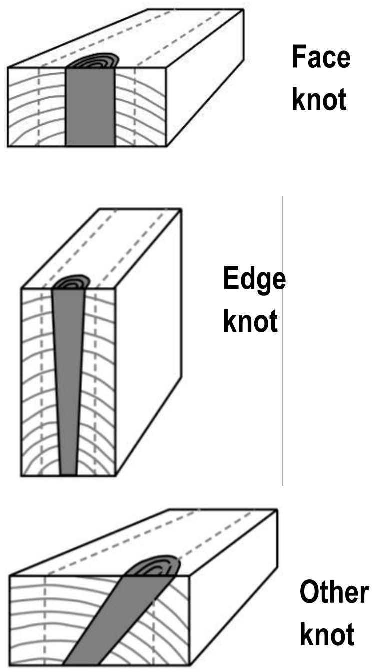
Measurement and assessment of characteristics

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 *Softwood 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 2858-2008: Timber - Softwood - Visually stress-graded for structural purposes*. There is a separate document for hardwood visual stress grading.

Knots

When you're grading softwood, the characteristic you'll spend most of your time looking at will be knots. It takes a while to get the hang of visually assessing knots, but the more you practice, the faster and more accurate you'll become.

Note that for this discussion on knots, we're not including cypress pine or hoop pine, because they have their own variations to the normal rules set out in AS 2858. However, the principles are the same, so if you're grading cypress or hoop, you simply need to look up the specific differences that apply.



The three basic types of knots used in softwood grading – *face knot, edge knot* and *other knot*.

The dotted line represents the 'central region' of the face / edge.

What is a knot?

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 softwoods, it doesn't matter whether the knot is tight (firmly trapped in the grain), loose, bark encased, or even a knot hole.

Because it is assumed that a knot contributes no strength to the timber, all of these variations are classified as knots.

Types of knots

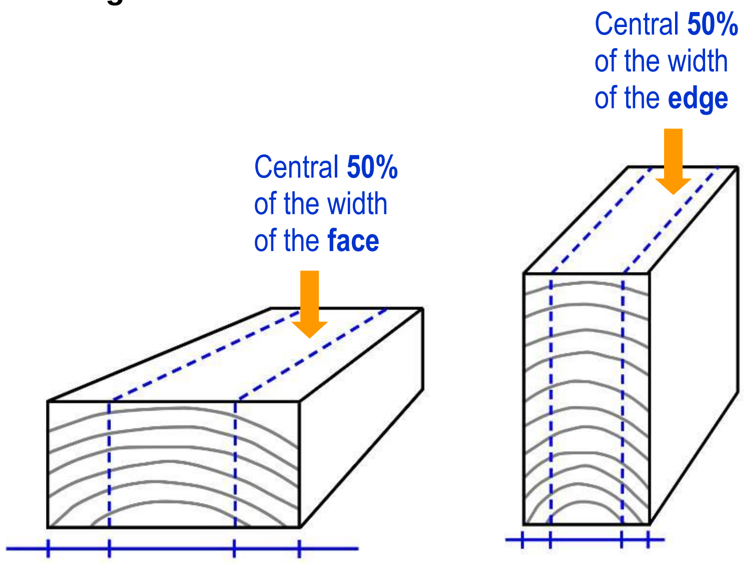
There are three basic types of knots in softwoods:

- **Face knots**, which are fully contained within the 'central face region' of the piece
- **Edge knots**, which are fully contained within the 'central edge region'
- **Other knots**, comprising all knots that don't fall into the above categories.

Central region of the face and edge

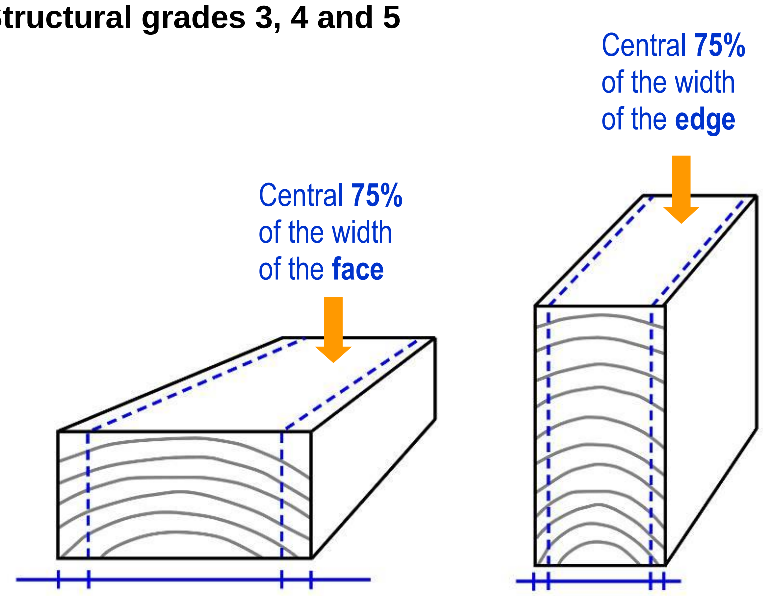
The central region of the face and edge varies, depending on the grade. In Structural grades 1 and 2 it represents 1/2 of the surface width, and in grades 3 to 5 it represents 3/4 of the surface. See the diagrams on the following page to see how you would visualise these regions on the face and edge of a board.

Central region for Structural grades 1 and 2



Fraction of surface:	1/4	1/2	1/4	1/4	1/2	1/4	
Measurements for 90 x 45:	22	45	22	11	23	11	(approx. mm)
Measurements for 70 x 35:	17	35	17	9	17	9	(approx. mm)

Central region for Structural grades 3, 4 and 5



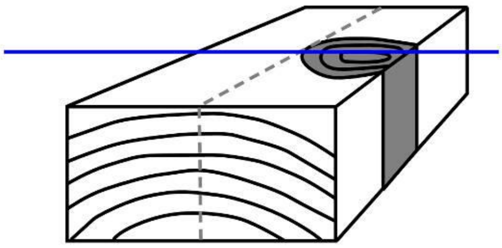
Fraction of surface:	1/8	3/4	1/8	1/8	3/4	1/8	
Measurements for 90 x 45:	11	68	11	6	33	6	(approx. mm)
Measurements for 70 x 35:	9	52	9	4	26	4	(approx. mm)

Assessing the size of knots

The size of a knot is measured in terms of its *Knot Area Ratio* (KAR). This is the area that the knot takes up inside the piece, expressed as a percentage of the end section of the piece.

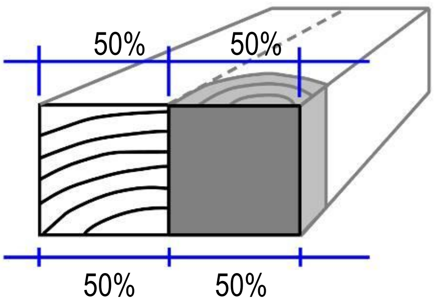
The *end section* is simply the end of the piece viewed front on, so its area is 100%. To find the KAR of the knot, you need to mentally cut through it at its widest point, look at the area it takes up on the end section you've just created, and estimate the area as a percentage. Have a close look at the following three examples.

KAR of 50%



This *other knot* comes halfway across the piece (shown by the dotted line).

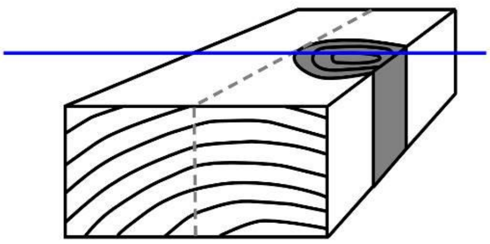
Dock through the knot at its widest point across the face.



Because the knot is the same size on the top and bottom faces, it will take up exactly half of the cross section of the piece.

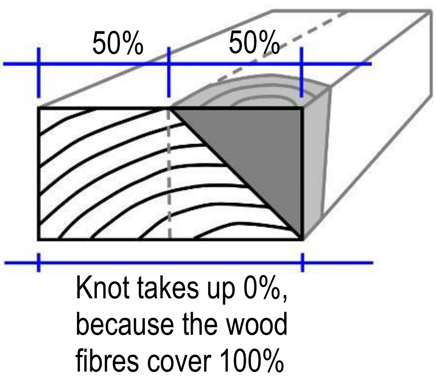
Therefore, it has a KAR of 50%.

KAR of 25%



This *other knot* comes halfway across the face of the piece, like the previous one.

But when you turn the piece over, you discover that the knot doesn't appear at all on the other face, because it runs off diagonally through the piece.

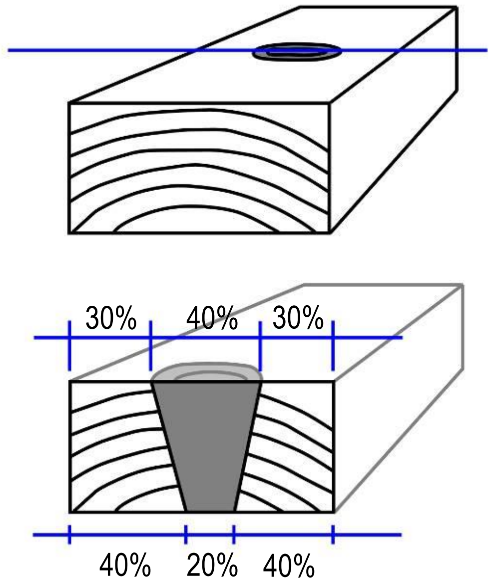


Now the knot only takes up a quarter of the end section. Therefore, it has a KAR of 25%.

If you wanted to calculate it mathematically, you could say:

$$\frac{50\%\text{ (top)} + 0\%\text{ (bottom)}}{2} = 25\%$$

KAR of 30%



This *face knot* is right in the centre of the piece.

But typical of softwood knots, it has a taper, so it's smaller on the other face.

On the top face, the knot takes up 40% of the width. On the bottom face, it takes up 20%.

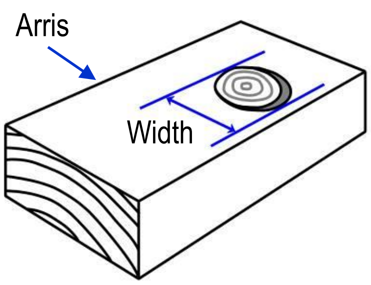
Therefore, the knot has a KAR of 30%, which is half way in between.

Mathematically, the KAR is:

$$\frac{40\%\ (\text{top}) + 20\%\ (\text{bottom})}{2} = 30\%$$

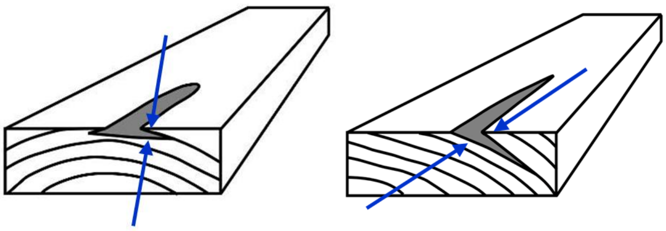
Measuring the width of a knot

When you assess the surface width of the knot, take the measurement at its widest point, at right angles to the arris of the piece. Make sure you include any bark or voids associated with the knot.



Resin, bark and overgrowths

Resin pockets, bark pockets and *overgrowths of injury* are all put into the same category in structural grading, because they all have the same effect on the strength of a piece, and are all measured in the same way.



These two resin pockets show how the direction of the 'width' measurement changes, depending on the orientation of the growth rings.

Because the width is measured *radially* (at right angles to the growth rings), the closer the board is to being fully backsawn, the more it becomes a 'depth' measurement.

On the other hand, the closer the board is to being fully quartersawn, the more it becomes a sideways measurement across the face.

Definitions

- **Resin pockets** are formed in the growing tree as a result of damage.
- **Bark pockets** are patches of bark that have been encased in wood tissue.

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

Assessing their size

The width of a resin pocket, bark pocket or overgrowth is measured radially – that is, towards the centre of the tree. The length is measured parallel to the length of the piece.

Slope of 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.

In softwoods, it's common 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 KAR calculations on the knots make allowance for it.

The same thing 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.

Detecting slope of grain

Sloping grain can sometimes be tricky to detect by eye, because the growth rings often run down the length of the board and make you think that the grain is doing the same thing.

But remember, *growth rings* are the alternation of early wood and late wood, and they form different patterns on the face of a board depending on the way it's been cut from the log. The *grain*, on the other hand, is the direction of the wood fibres, and it may or may not run in line with the growth rings.

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.

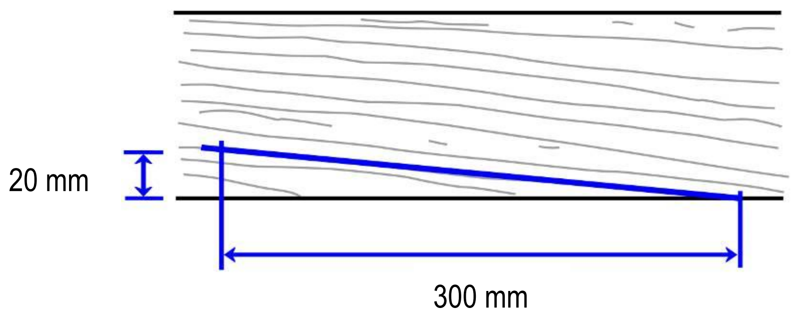
Measuring slope of grain

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 of grain will be 1 in 10.

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

The example below shows a rise of 20 mm to a run of 300 mm. Therefore:

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



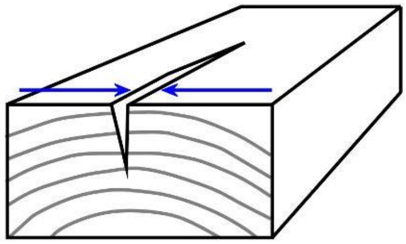
Checks, splits and shakes

There are various forces that can cause wood fibres to separate and show up as cracks in a board. Sometimes they occur in the growing tree, other times they develop while the timber is drying, and they can also happen due to mishandling.

The most common types of cracks or fissures in the grain are *checks, splits* and *shakes*. Because they have different effects on the strength of timber, they are treated differently in the grading rules.

Checks

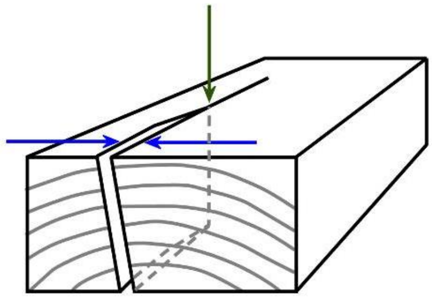
Checks generally form as the result of drying stresses, where the wood fibres pull away from each other because different areas are shrinking at different rates. They always run lengthwise with the grain, and their depth is radial to the growth rings – that is, towards the centre of the tree.



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's 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.



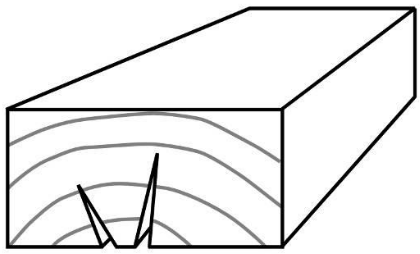
Note that where a separation of fibres begins as a split and then disappears on one surface, it becomes a check from that point on. In the diagram above, the dotted line indicates where the split stops on the underside. This is marked by the green arrow on the top face, so from that point the crack turns 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 only permitted within strict limitations in the lower grades.

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.



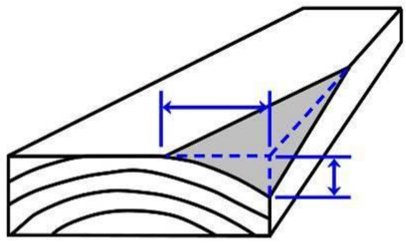
Like splits, they have a serious effect on the strength of a piece, and in most instances are not permitted in any grade. The diagram above shows a heart shake, which radiates from the heart of the tree, often in the form of a star pattern. Heart shakes are permitted in the lower grades if they're no worse than an equivalent sized check or end split.

Want and wane

Want and wane are caused by different things, but because they have the same effect they're both measured in the same way.

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.



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

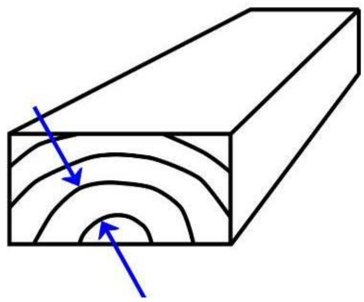
Width of growth rings

During the early development of a tree, while it's still a sapling and growing quickly, the wood fibres tend to have a lower density than in later growth in the more mature tree.

For this reason, the first 50 mm radius from the centre of the tree needs to be visually assessed, to make sure that you're not allowing low strength material to get through in a board

The wider the growths rings are apart, the lower the density is likely to be. There are certain restrictions in AS 2858 on the maximum distance between grown rings, depending on the grade.

For more general information about growth rings, and the method for determining how close they are to the pith, go back to the *Growth rings* webpage in the on-line resource.



Width of growth rings is measured radially, that is, towards the pith. Measure from the start of one latewood band to the start of the next latewood band.

Note that you only need to check the width of the growth rings if the piece has been cut from the central 100 mm diameter, or 50 mm radius, of the tree.

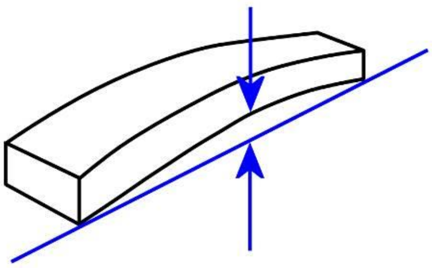
Distortions in the board

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 from straightness and flatness 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 2858 specifying the maximum amount of bow, spring, twist and cup that are allowed in a board. Once the distortion exceeds that level, it is rejected from the grade.

Bow

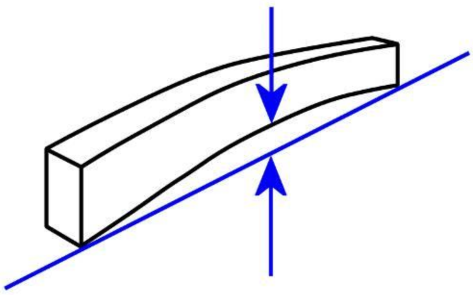
Bow is a curve along the length of a board that causes the face (wide surface) to move away from a flat plane. That is, if the board is laid down flat with the bow facing up, the board will rise in the middle.



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

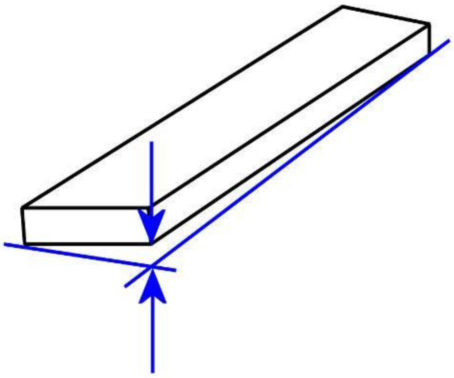
Spring is a curve along the length of a board that causes the edge (narrow surface) to deviate from a straight line. That is, if the board is turned on its edge, it will rise in the middle.



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.



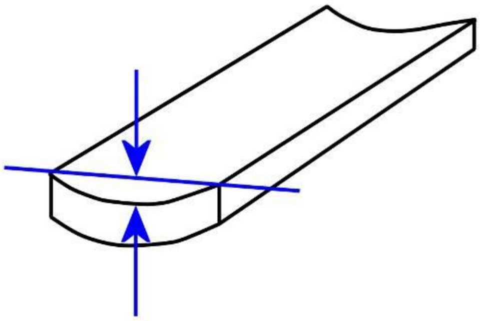
Lay the board down flat on a perfectly flat base. Measure the distance between the base and the raised corner of the board while holding the rule at right angles to the base.

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.



Combinations of characteristics

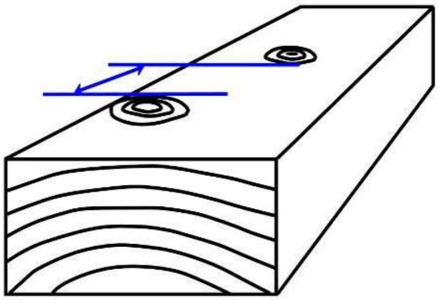
When particular defects occur close to each other, their combined effect on the strength of the board tends to be worse than their individual effects.

For this reason, there is a rule in AS 2858 regarding *combinations of characteristics.*

The combination rule is that if two characteristics occur within 150 mm of each other, or twice the width of the board – whichever is the lesser – then their strength-reducing effects have to be added together.

If you're grading a 70 mm wide board, you'll use the 'twice the width' calculation, because 2 x 70 = 140 mm, which is less than 150 mm.

But for boards 90 mm wide and greater, you need to assess any characteristics within 150 mm of each other in combination.



The distance between two characteristics is measured by finding the points that are closest to each other, and measuring between them, parallel to the length of the piece.

If we assume that the piece of timber above is 90 x 45, these two knots must be considered in combination if the distance between them is 150 mm or less.

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.

The most common combinations you're likely to come across are knots. However, any strength-reducing characteristics occurring within the 150 mm or twice the width need to be assessed in combination, including resin pockets, sloping grain, checks, splits and shakes. The only characteristics that aren't considered in combination are distortions in the board – that is: bow, spring, twist and cup. These need to be assessed separately.

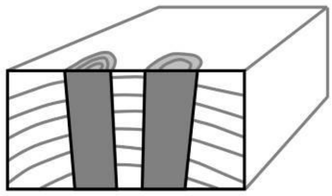
Adding sizes together

Example of two similar characteristics

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

For example, if two face knots are in combination, and their KARs are 20% and 25%, then their total KAR as a combination is:

20% + 25% = 45%.



Face knot 1: KAR 20%

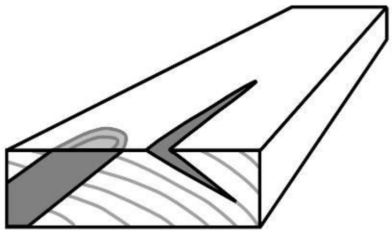
Face knot 2: KAR 25%

Combination of face knots: KAR 45%.

Example of two characteristics of different types

If the characteristics are of different types – such as a *face knot* and an *other knot*, or an *other knot* and a *resin pocket* – then you should work out each characteristic's proportionate size as a percentage of the maximum allowed for that type and the stress grade you are considering, and add the two proportions together.

For example, if the *other knot* is 40% of the maximum allowed for an *other knot*, and the *resin pocket* is 50% of the maximum allowed for a *resin pocket*, then the combination would be: 40% + 50% = 90%. This combination would therefore be assessed as 'in grade'.



Other knot: 40% of maximum allowed for the grade

Resin pocket: 50% of maximum allowed for the grade

Combination: 90% of maximum allowed for the grade