Workspace Training

Grading structural softwoods

Learner Guide

Supporting:
FPICOT2216A:
Visually stress grade softwood

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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 ***Grading structural softwoods*** e-learning unit developed by McElvenny Ware for the Australian Flexible Learning Framework in 2010.

The Grading structural softwood 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/

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Introduction

This house uses radiata pine wall frames and roof trusses. All of the pieces that perform a structural function have been stress graded in the sawmill – either visually or mechanically.

Stress grading allows the builder and home owner to have confidence in the structural integrity of the building.

When timber is used in a structure, it needs have reliable strength properties. The strength of a structural member is what allows it to withstand the *stresses* that act on it. These stresses come from things like wind gusts that blow from different directions, people or heavy objects inside, and of course, the dead weight of the structure itself.

Stress grading is all about taking into account the things that affect the strength of a piece of timber, and then giving it a grade that matches its ability to withstand stresses.

When the grading is done by a person who physically looks for the strength-reducing characteristics, it's called *visual stress grading*. When it is done by a machine, it's called *mechanical stress grading*.

In this unit, we'll be concentrating on the background knowledge needed to visually stress grade softwoods, although we will also briefly look at the principles of mechanical stress grading.

Background knowledge you should already have

Visual stress grading is very much a practical application of wood technology concepts. It will be very helpful for you to complete the Learner Guide **Selecting timber** before undertaking this grading unit, so that you have a good understanding of how certain growth characteristics in trees affect the properties of wood.

You should also get a copy of the Australian Standard covering the visual stress grading of softwood. This is called: *AS 2858-2008: Timber – Softwood – Visually stress graded for structural purposes.* Each time the Standard is revised, the year is updated – so you can see that the last update was made in 2008. If your company doesn't have a copy that you can have to study, you can buy your own copy via the **SAI Global** website, at: http://www.saiglobal.com/

Section 1: Principles of stress grading

Your job

Stress grading involves assessing the characteristics in a piece of timber that have an effect on its strength, and deciding on a grade that reflects its ability to withstand particular stresses.

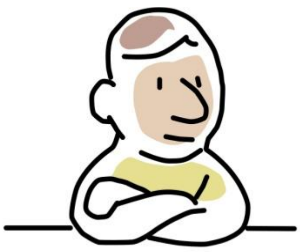
In this section, we'll examine the types of stresses timber is subjected to in a structure, and then discuss the general principles of stress grading. Although the main focus of this unit is on *visual assessment* using AS 2858, there are a range of 'visual over-rides' that apply to timber that has been graded by a machine. So we'll briefly look at the process of mechanical stress grading as well.

Note that the visual over-rides used for mechanically stress graded timber aren't actually part of AS 2858, so if you're involved in this aspect of softwood grading, you will need to consult another Australian Standard: AS/NZS1748:2006 – *Timber – Mechanically stress-graded for structural purposes.*

This timber grader is working on-line in a softwood mill. He is using a crayon to mark the points where the boards need to be docked to remove large defects.

An 'optimising docking saw' will scan the piece to look for the crayon marks and dock the piece accordingly. The remaining length will then make the grade allocated to it.

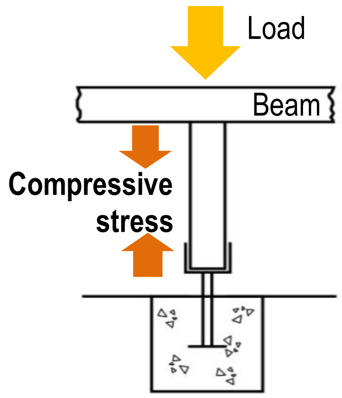
Here's your job



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.

Types of stresses

Structural timber needs to withstand four basic types of stresses.
These are:

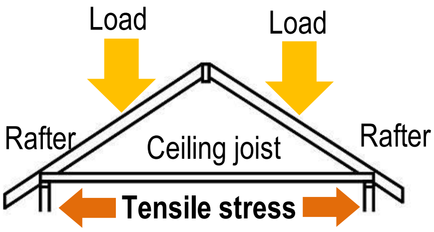


Compression

A load which tends to shorten or crush a member produces *compressive stresses*.

This particularly applies to supporting members, such as a post supporting a beam.

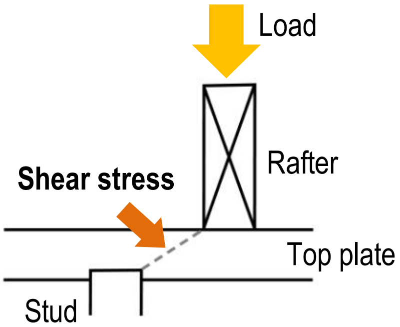
Tension



A load which tends to stretch a member produces *tensile stresses*.

This happens to members designed to stop a pulling-apart action, such as a ceiling joist fixed to the foot of two rafters, resisting their tendency to spread apart under the roof load.

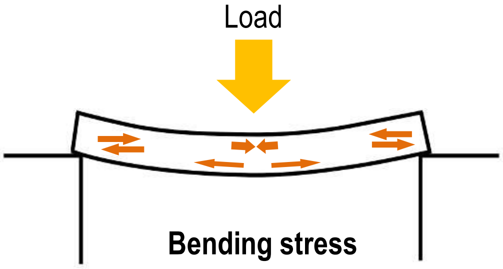
Shear



A load which tends to slide one part of a member over an adjacent part produces *shear stresses*.

This can occur in places where a defect in the member might weaken the wood fibres and cause them to split along the grain, such as in the top plate of a wall frame.

Bending



When a load is applied to the middle of a beam supported at both ends, it tends to bend the piece, producing *bending stresses*.

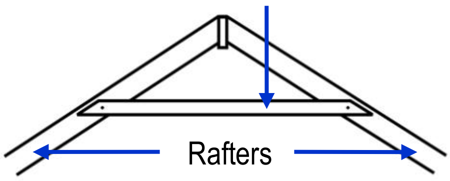
But when you look more closely at it, bending is really a combination of compressive, tensile and shear stresses.

This is because:

- the top part of the beam tends to shorten, producing compressive stresses
- the bottom tends to lengthen, producing tensile stresses
- the interaction of compressive and tensile stresses produce shear, as the different layers try to slide over each other.

Learning activity

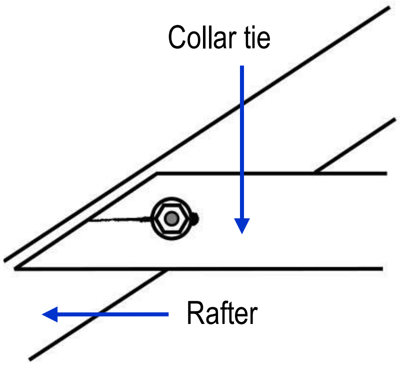
Below are four examples of structural members under stress. For each one, identify the type of stress that the member is being subjected to.



Example 1

This collar tie is fixed between two rafters in a roof. When the tiles go on the roof, the rafters will tend to spread, with the ridge (where they join together at the top) acting like a hinge.

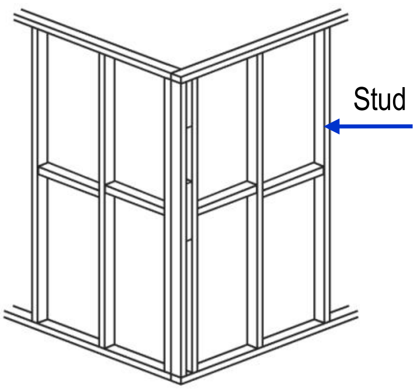
What stress is the collar tie under?



Example 2

This is a close up view of the fixing point at one end of the collar tie. When the rafter tries to spread outwards, it will pull against the bolt, because the collar tie is pulling back in the other direction.

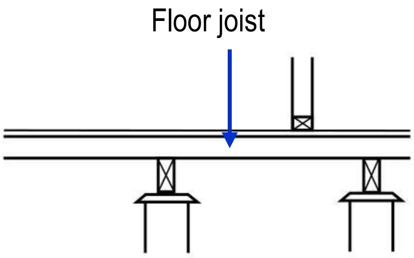
What stress is the grain being subjected to in the end of this collar tie?



Example 3

This stud is in a wall frame. When the rafters sit on top of the wall frame, it will be bearing the weight of the roof.

What stress will the stud be under when the roof goes on?



Example 4

This floor joist is supported by bearers (shown in end section), which are sitting on brick piers. There is an internal wall frame sitting on top of the floor, in between the two bearers.

What stress is the floor joist under in between its supports?

Strength groups

All timber species graded for structural purposes are classified into *strength groups*. Because most species become stronger when they are seasoned, there are two sets of strength groups – one for green timbers, ranging from S1 (the strongest) to S7; and one for dry timbers, ranging from SD1 (S for strength, D for dry) to SD8.

You can see from the list below of typical species in the different strength groups that the density of the timber has a big influence on its strength. This is because density is closely related to the thickness of the cell walls in the wood fibres.

The right hand column shows the density, either green (GD) or air dried (ADD) measured at an average of 12% moisture content. For more information on these two methods of recording density, see the chapter **Density** in the unit: **Selecting timber**.

Density is the single biggest factor influencing the strength of a piece of timber. Even within a species, the denser a board is the stronger it will be, all other things being equal.

These radiata pine boards have differing densities – you can tell by looking at how close together the growth rings are. The pieces with close growth rings are slower growing and denser; in general they'll produce higher grades.

The density value given to a species is based on the average density of the wood produced.

Strength groups and typical species

Species	**Strength group** (unseasoned)	**Green density** (GD)	**Strength group** (seasoned)	**Air dried density** (ADD)
Grey ironbark (Eucalyptus paniculata)	S1	1250	SD1	1100
Blackbutt (Eucalyptus pilularis)	S2	1150	SD2	900
Messmate (Eucalyptus oblique)	S3	1100	SD3	750
Jarrah (Eucalyptus marginata)	S4	1100	SD4	800
Douglas fir (oregon) (Pseudotsuga menziesii)	S5	710	SD5	550
Radiata pine (Pinus radiata)	S6	800	SD6	550
Light-red meranti (Shorea spp.)	S6	-	SD7	400
Western red cedar (Thuja plicata)	S7	-	SD8	350

Learning activity

Did you know that on a strength to weight ratio, some species of timber are stronger than steel? Douglas fir is one example, which is why it has traditionally been used in many critical applications, including boat masts and aeroplane frames. Sitka spruce is another, and for a long time was the preferred species for aircraft manufacture, including in the largest plane ever built – Howard Hughes's 'Spruce Goose'.

There are many other examples of timber being used in particular applications that require high performance characteristics, especially in relation to strength. Modern mass production methods have meant that a lot of these traditional uses have disappeared into history – but not always because the replacement materials, such as steel, aluminium and plastics, performed better. Often it was simply due to the cost effectiveness and the reduced availability of high grade timber. However, there are still instances where timber is used in engineering applications, because it is the best material for the job.

How many examples can you think of – either historical or current – of timber being used in engineering applications? Do you know which species are specified for those end uses?

Structural grades and stress grades

A grader visually assesses slash pine and stamps each piece with the stress grade as he goes.

Strength groups are a good starting point for working out how much stress a piece of timber can withstand, but their problem is that they only give you the average strength for the species. And even then, the strength group allocation is based on the testing of small clear samples of the timber without any imperfections. In practice, individual pieces contain a variety of defects, such as knots, splits and resin pockets.

Because the size and occurrence of these defects can have a serious effect on strength, each piece needs to be assessed according to its *structural grade*. For softwoods there are five grades – Structural grade No. 1 is the strongest, and each lower grade represents a 25% reduction in strength.

Each structural grade also has an *F rating*. F stands for force in megapascals (MPa). This is the amount of force a piece of timber can withstand without bending beyond an acceptable limit. A piece graded to F11, for example, will have *a safe working stress in bending* of 11 MPa. This is also called the *stress grade* of the piece.

The reason for having structural grades and as well as stress grades is that it allows a single set of grading rules to be used for a wide range of species – the structural grades categorise the allowable size and number of particular defects, and the stress grades (i.e. F grades) tell you how strong the piece is after allowance is made for those defects in a piece of timber from that particular strength group.

An example

To understand this idea more clearly, have a look at the table below. This shows a comparison in stress grades between two softwoods. Notice that the slash pine is denser than western red cedar, and comparatively stronger. So when the defects in a piece of slash allow it to be given a Structural grade 1, its stress grade will be F14 – that is, it can take a load of 14 megapascals without bending too much. But a piece of cedar with exactly the same sized defects, and therefore still given a Structural grade 1, will only make a stress grade of F8, because the wood itself is naturally weaker.

We'll look more closely at the different types of defects and other strength-reducing characteristics in Section 2: *Assessing characteristics*, but for now, the important thing is that you understand the relationship between strength groups, structural grades and stress grades.

Standard trade name	Air dried density (12% MC)	Strength group	Stress grade (F grade)				
			Structural grade number				
			1	2	3	4	5
Slash pine	470	SD5	F14	F14	F11	F8	F7
Western red cedar (USA)	360	SD8	F8	F7	F5	F4	-

In-grade testing

Although the traditional F grading system we've just described has been used successfully for many years, it was originally developed for hardwoods, which tend to have a lot less knots than the softwoods. When the test results of small clear samples of hardwood are generalised to full length pieces in that species, the estimations of how they will perform under a load are reasonably accurate.

But in the case of the some of the softwoods, it has turned out that full length pieces don't always perform the way the testing of small clear samples predicted they would. For this reason, there have been various revisions made to the F grade allocations of particular softwood species, based on 'in-grade' tests of full length pieces.

So you need to remember whenever you're looking at a general table of strength groups, structural grades and stress grades that for certain species of softwood there are now revised F grades that over-rule these generalised grade allocations.

The tables below show the F grades for some commonly used softwood species. These include the updates made to particular species as a result of in-grade testing.

Stress grades for unseasoned softwoods

Standard trade name	Strength group	Stress grade (F grade)				
		Structural grade number				
		1	2	3	4	5
Caribbean Pine	S6	F8	F7	F5	F4	-
D. fir (oregon) (North America)	S5	F11	F8	F7	F5	F4
D. fir (oregon) (Elsewhere)	S6	F8	F7	F5	F4	-
Radiata pine (Aust)	S6	F8	F7	F5	F4	-
Radiata pine (NZ)	S6	F8	F7	F5	F4	-
Slash pine	S5	F11	F8	F7	F5	F4
Western hemlock	S6	F8	F7	F5	F4	-
Western red cedar (Canada)	S7	F5	F4	-	-	-
Western red cedar (USA)	S7	F7	F5	F4	-	-

Note that cypress and hoop are listed separately in AS 2858, and have their own grade descriptions. These are as follows.

Standard trade name	Strength group	Stress grade (F grade)		
Cypress pine	S5	F7	F5	F4
Hoop pine	S6	F7	F5	F4

Stress grades for seasoned softwoods

Standard trade name	Strength group	Stress grade (F grade)				
		Structural grade number				
		1	2	3	4	5
Caribbean Pine	SD6	F11	F11	F8	F7	F5
D. fir (oregon) (North America)	SD5	F11	F11	F8	F7	F5
D. fir (oregon) (Elsewhere)	SD6	F11	F11	F8	F7	F5
Radiata pine	SD6	F8	F8	F7	F5	F4
Slash pine	SD5	F14	F14	F11	F8	F7
Western hemlock	SD6	F11	F11	F8	F7	F5
Western red cedar	SD8	F8	F7	F5	F4	-

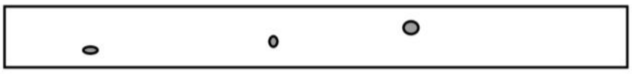
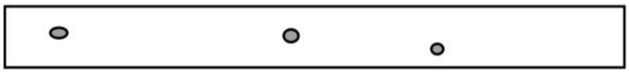
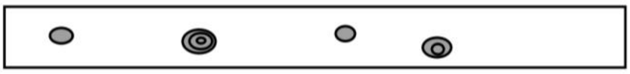
Note that cypress and hoop are listed separately in AS 2858, and have their own grade descriptions. These are as follows.

Standard trade name	Strength group	Stress grade (F grade)		
Cypress pine	SD6	F7	F5	F4
Hoop pine	SD5	F8	F7	F5

Learning activity

Below are four boards that have been given a structural grade, based on the size and location of the defects. See if you can give each board its correct F grade. You will need to look up the two stress grade tables shown above to match up the species, seasoned/unseasoned condition, and structural grade with the appropriate stress grade.

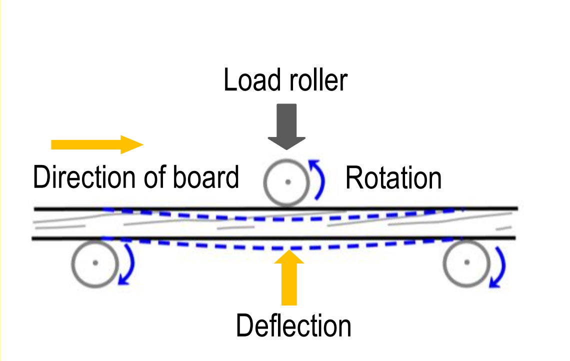
When you have decided on your answer, write the appropriate F grade on the end of the board.

Species	**Green/ Dry**	**Structural Grade**	Write the grade here
Radiata pine	Dry	1	
Slash pine	Dry	1	
NZ oregon	Green	3	
American oregon	Green	3	

F grading with a machine

In *mechanical stress grading*, the stick of timber is bent in a machine and measured in terms of its resistance to deflection. This is then converted to a stress grade via the machine's computer. Traditionally, mechanical stress grading machines always used F grades. However, the plantation pines are now generally stress graded using the MGP (machine graded pine) system. The process of physically bending the piece

In order to understand how a machine stress grader calculates F grades, it's important to know the difference between *bending strength* and *bending stiffness*.



This diagram of a machine stress grader shows how the machine measures the stiffness of a board.

The *load roller* applies a force to the board, and bends it between two support rollers. The blue dotted line represents the deflection that occurs.

As the rollers rotate, the board moves through the machine, so that the deflection can be measured very quickly right along the length of the board.

Bending strength

The *bending strength* of a piece is derived from the point at which the piece breaks under a load, called the Modulus of Rupture (MOR), since this is the pressure required to actually rupture the fibres. The F grade of the piece is based on the MOR divided by a safety factor.

This is why the F grade is called the *safe working stress in bending*.

That is: **F grade** = safe working stress in bending

$$= \frac{\text{modulus of rupture (MOR)}}{\text{safety factor}}$$

Bending stiffness

By contrast, the *bending stiffness* of a piece is a measure of its Modulus of Elasticity (MOE). The higher the MOE, the less elastic it will be – so the more resistant it is to deflection under a load.

That is: **Stiffness** = modulus of elasticity (MOE)

= resistance to deflection

Fortunately, there is a close relationship between MOR and MOE. If there wasn't, the machine would have to break every piece to find its actual point of rupture before it could derive an F grade. But because the stiffness of the board is a good indication of how much stress it can take before the fibres rupture, the machine can measure the MOE by running the timber across two rollers spaced apart, and use a formula to work out the MOR and then the F grade.

In most boards, the grade will vary along the length, depending on the size and positioning of knots and other defects. So the machine sprays bursts of paint along the piece to mark the different grades, and uses the lowest one as the overall grade. This is generally shown on the end of the board in a long stripe of colour.

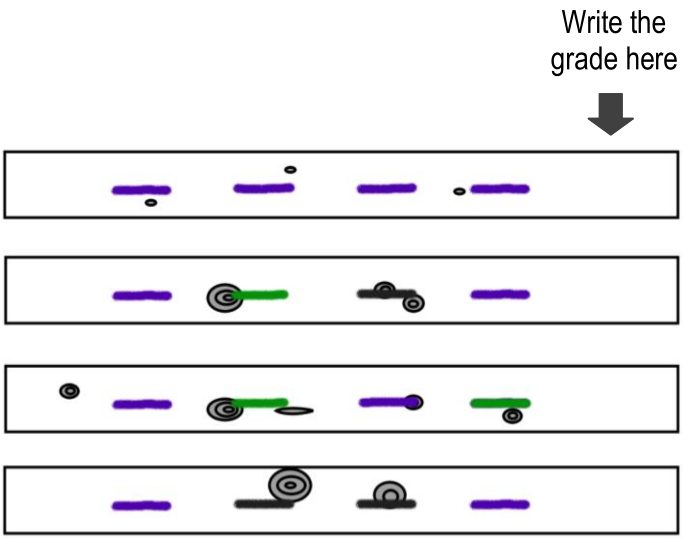
The colour codes used for the most common softwood F grades are:

F4:	red
F5:	black
F7:	blue
F8:	green
Fll:	purple

Learning activity

Below are several boards that have just come through a machine stress grader. There are spray bursts indicating the varying strengths along the length of each board as the different defects and other characteristics pass under the load roller.

The overall grade for each piece has not yet been decided on. Your job is to look at the paint colours sprayed by the machine and write the correct grade on the end of the board.



MGP grading with a machine

This machine stress grader bends the timber as it runs through the rollers, and measures its resistance to deflection, or 'modulus of elasticity'. The MOE value then becomes the basis for the MGP grade, which is marked along the board with colour-coded paint.

We talked about in-grade testing in the earlier lesson: *Structural grades and stress grades*. These tests found that the F grading system was not as accurate for some of the pines as it was for most other timbers, especially hardwoods. In order to overcome this problem, a new set of MGP (machine graded pine) grades was developed, specifically designed to describe the properties of pine.

The MGP system is based directly on the 'modulus of elasticity' (MOE) of the timber. You'll recall that we said in the last lesson – *F-grading with a machine* – that MOE is a measurement of stiffness, and the higher the MOE, the stiffer (in other words, less 'elastic') the timber is. So the MGP grade designations given to the boards tested by a machine stress grader are simply an abbreviated form of the MOE category that the timber falls into.

For example:

- **MGP 10** has an MOE of 10,000 megapascals (MPa)
- **MGP 12** has an MOE of 12,700 MPa
- **MGP 15** has an MOE of 15,200 MPa

Using MGP timber in place of F graded timber

Remember that when a piece of timber is machine stress graded under the F grading system, its basic bending strength is calculated from the MOE value. Because this isn't a direct measurement of its *bending strength* (which is based on the *modulus of rupture*, divided by a safety factor), there needs to be a greater allowance for error.

By contrast, the properties of MGP graded timber are measured more accurately, allowing pieces to be used closer to their design limitations, with less margin for error. This is why some end users of structural pine say that the defects in MGP pine sometimes look bigger than they do in the F grades equivalents.

Nonetheless, the properties attributed to MGP pine are all greater than those of the F grades they can be substituted for. Below are the three main MGP grades and the F grades they can replace.

- **MGP 10** can replace **F5**
- **MGP 12** can replace **F8**
- **MGP 15** can replace **F11**

When you're reading span tables or specifying grades, it's important to note that MGP grades and F grades can't simply be used interchangeably. MGP material may be substituted for F graded material, as shown above. But F graded material must not be used where MGP material has been specified. This is because of the differences in design properties between the two systems.

Learning activity

The following questions draw on information covered in this lesson as well as the previous lesson: *F grading with a machine*. If you have trouble answering these questions correctly, make sure you go back over the topics to check your understanding of the concepts.

Answer True or False to the following questions.

1. Modulus of elasticity (MOE) is a measure of stiffness, so a board with a high MOE will have less deflection when it's put under a load than a board with a low MOE.

2. A person can learn to visually stress grade timber using both the F grade system and the MGP system.

3. If a plan specifies F5 for a particular member, you can use a piece of MGP 10 in its place.

4. If a plan specifies MGP12 for a particular member, you can use a piece of F8 in its place.

Visual over-rides for MSG softwoods

This mill grader is visually assessing the timber that has come through a machine stress grader, and putting a sticker on pieces that make the grade. The pieces that don't make a specified grade are sent back to be re-worked.

Although timber graded with a mechanical stress grader (MSG) is physically bent by the machine to measure its stiffness, a person still needs to visually check each piece for defects that the machine might have missed before the piece is given a grade. For example, defects that affect shear strength, such as sloping grain, resin and bark pockets, and fractures are very difficult for machine stress graders to recognise. The same goes for things that affect straightness, such as bow, spring and twist.

It's a good idea for everyone who handles MGP timber to have a general understanding of the visual over-rides that apply, because there may be times when a piece will get through the quality control process that isn't up to grade. There are also various problems that can appear or get worse after the timber has been graded and left the sawmill – in particular those defects that are affected by changes in moisture content.

If you come across pieces that clearly don't make the standard required, you shouldn't use them, even if they are stamped with that grade. This particularly applies to timber going into wall frames, roof trusses or other structural applications. You might think at the time that it's too much effort to cut the out-of-grade defects out of the piece, or put the whole piece to one side, but in the long run it could save you a lot of trouble.

If you find that a lot of pieces in a pack are not making the grade they're stamped with, you should contact the mill that supplied the timber and ask them to send out a rep to discuss the problem.

On the following page is a table of visual over-rides that apply to all machine stress graded softwoods that are kiln dried and planer gauged or dressed. The species you're most likely to use this with are radiata and slash pine. For definitions of the characteristics listed in this table, and methods of measurement, see the next section: *Assessing characteristics*.

Visual over-rides for machine stress graded softwoods AS/NZS 1748:2006

Note: This is a summary only of the visual over-rides that apply to K/D P/G MSG softwoods under AS/NZS1748:2006. For a full description of all grade requirements, consult the Standard.

Characteristic	Limitation
Cross shakes and splits other than end splits	Not permitted
Cupping	1 mm per 50 mm of width
End splits	Maximum individual length: ½ width of piece; Aggregate length at each end: lesser of 2 times width or 200 mm
Finished dressed size	+2 mm, -0 mm on specified width and thickness
Heart shakes	Maximum width: 3 mm; Not one surface to the opposite surface
Knots	To the limits allowed to meet the specified strength and MOE
Machine skip	Maximum -0.5 mm when extending for full length of the piece
Moisture Content	15% maximum for at least 90% of pieces
Resin streaks, resin pockets, bark pockets	Not one surface to the opposite surface if longer than the width of the piece
Squareness	±0.5 degree from a right angle (equivalent to less than 1 mm per 100 mm)
Want and wane	Maximum 1/2 face and 1/3 edge

Length (m)	**Bow** (mm)	**Spring** (nom. width mm)		**Twist** (nom. width mm)			
		Up to 125	150 & up	Up to 100	101– 150	151-200	201-300
Up to 2.4	20	6	6	5	7	10	15
3.0	30	9	9	7	10	14	20
3.6	40	18	14	8	13	18	25
4.2	50	22	18	9	15	21	29
4.8	60	29	24	10	16	23	33
5.4	65	36	30	11	18	26	37
6.0 & over	70	44	36	12	20	28	40

Learning activity

When you look at the summary table above, you'll see that there are a lot of abbreviations used to help condense the information into a small space. Most of these abbreviations are in common usage throughout various industries, particularly those relating to manufacturing or building.

We won't go into the definition and measurement of the defects listed in the table, because that will be covered in the next section of this unit. But for now, see if you can pick the correct answer for each of the questions below on the meanings of the common abbreviations used.

1. AS/NZS stands for:
   (a) All Services under the New Zealand System
   (b) Australian Standard / New Zealand Standard

2. K/D stands for 'kiln dried', which means that the timber has been:
   (a) dried in a kiln to a moisture content of 15% maximum (unless specified otherwise)
   (b) dried in a kiln until the timber loses its surface moisture

3. P/G stands for 'planer gauged', which means that the timber has:
   (a) a planed surface on all four sides, gauged to a specific size, so that the piece has reliable width and thickness dimensions
   (b) a groove running down the centre of the board which is gouged out with a planer.

4. If a piece of 90 x 35 has a size tolerance of +2 mm, -0 mm, it means:
   (a) the piece can be up to 92 mm wide and up to 37 mm thick, and still be within the specification, but it can't be any less than 90 mm x 35 mm.
   (b) the end of the piece can be cut up to 2 mm out of square.

5. If the squareness tolerance of a piece is ±0.5 mm, it means
   (a) the angle between the face and edge can vary slightly from a perfect right angle, as long as it is no more than half a millimetre out of square.
   (b) the length of the piece must be no more than half a millimetre longer or shorter than the length specified.

Task for Section 1: Principles of stress grading

The purpose of this Task is to prepare you for the practical grading demonstration you will need to perform for Section 2 of this unit: *Assessing characteristics*. You will need to speak to your trainer or supervisor about the species you'll be using in your hands-on grading demonstration, and then answer the questions set out below.

Most of the information you'll need will be in the lessons for this section. However, you may also need to look up some of the tables in the Learner Guide: *Selecting timber*.

1. Description of species

Nominate the common name, botanical name, country of origin, strength group (unseasoned), and strength group (seasoned) for the timber.

2. F grades

Specify whether the timber you will be grading is seasoned or unseasoned, and then fill in the appropriate F grades that will apply.

3. Structural uses and stresses

Think about the types of structures this timber is typically used in. List three different types of stresses that the timber would need to be able to withstand, and for each one, give at least one example of a structural member that would be subjected to that stress.

Section 2: Assessing characteristics

Your job

There are lots of characteristics in timber that can influence strength. Some characteristics, such as fractures, are serious defects and therefore not allowed in any grade. Others, such as knots and resin pockets, have a relative effect on strength, depending on how big they are and where they occur in the piece.

In this section, we'll look at the main characteristics you need to be able to identify and measure when you're visually stress grading softwood. We'll concentrate on the general grade descriptions listed in Part 2 of AS 2858-2008.

However, you'll notice that Part 3 of the Standard deals specifically with cypress pine, and Part 4 covers hoop pine. These two timbers have been given their own subsets of grading rules, because they tend to behave a bit differently from the other softwoods due to their knot configurations and grain structure.

A supervisor works with a trainee grader, showing her how to evaluate characteristics and decide on the correct grade.

He doesn't mind the fact that progress is slow at first, because he knows that the best graders are the ones who have taken the time to really 'get it' – they ask lots of questions, study the grading rules closely, and learn all the fundamentals before starting to pick up the pace to normal production speed.

Learning the process

To learn to become a good grader, you'll need plenty of practice under the guidance of a face-to-face trainer or supervisor, because there will be many times when you'll question whether a particular imperfection falls into one category or another, or whether a borderline measurement should put a piece into a lower grade or a higher grade. The ability to make good quality grading decisions will come with practice, and a sound knowledge of the particular species you are working with.

So it is not the intention of this section to give you everything you need to know in order to identify and assess characteristics accurately. But the lessons in this section will help you to develop an understanding of how to evaluate the most common characteristics described in AS 2858. From there you will simply need to keep practicing your skills and gradually learn from experience to apply these principles correctly to the many variations you will be presented with when you're grading at work.

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.

Looking at the piece

There are two main types of characteristics that you need to look for when you visually grade structural timber:

1. characteristics that have a strength-reducing effect on the piece, such as knots, resin pockets, and sloping grain
2. characteristics that affect straightness, and therefore usability, such as bow, spring and twist.

The only way to be sure that you don't miss anything important is to inspect all four sides and both end of every piece. If you're working on a production line and need to grade pieces quickly, it's best to have an offsider checking the far ends for you as they come down the line.

This grader quickly turns the piece while looking up and down the board, and uses a crayon to mark the characteristics that need to be docked out.

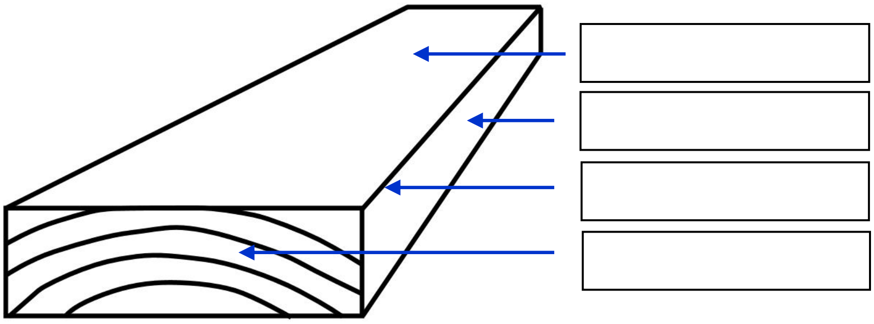
It's not easy working quickly without sacrificing accuracy, but that's part of the skill of being a good grader. Fortunately, you don't need to study every defect in the piece – you only need to assess the worst characteristic, because that will be the one that determines the grade. So the trick is to roll the piece while you look up and down all surfaces, find the feature or combination of features that will give you the lowest grade, and then make your assessment.

If you're reworking the pieces and cutting out bad defects, you need to make the judgement as you go about whether it's best to leave the piece long at a lower grade, or dock the piece to a shorter length and get a higher grade. You may also be re-sawing the width of the boards, in which case you have to decide whether a large imperfection on a wide board is better than a smaller one on a narrower board. Obviously, if the defect you're looking at is bad enough to reject the piece completely, then re-working it will be your only option.

Learning activity

Terms like ‘face’, ‘edge’, ‘width’ and ‘size’ have strict meanings when referring to timber. This exercise is designed to reinforce the correct meaning of each term.

1. Write the correct term for each of these surfaces, and the line where the surfaces meet.



This piece of 140 x 45 oregon is 2.4. metres long. Therefore:

The ________ of the board is 140 mm

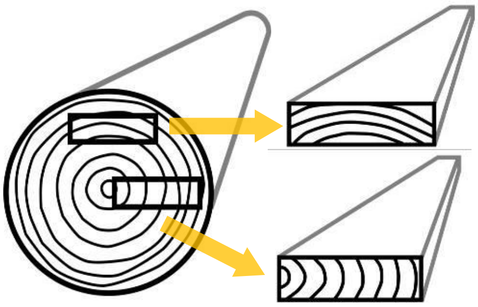
The ________ of the board is 45 mm

So the ________ is 140 x 45 and the ________ is 2.4 metres.

2. Another two terms that you will come across in visual stress grading are *backsawn* and *quartersawn* – which refer to the way the board is cut from the log. The general definition is:

- If the growth rings are less than 45 degrees to the face, the board is backsawn
- If the growth rings are more than 45 degrees to the face, the board is quartersawn.

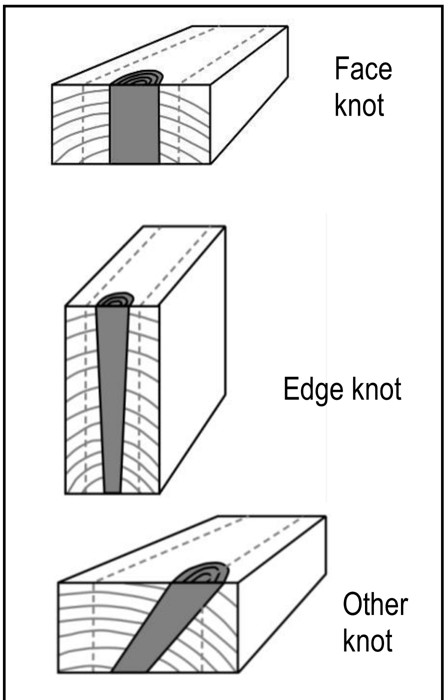
Match up the correct term to each of the boards below by writing boxes provided.



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 or edge.

What is a knot?

A knot is a section of the branch of the tree, cut through in section 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 (liable to fall out), 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

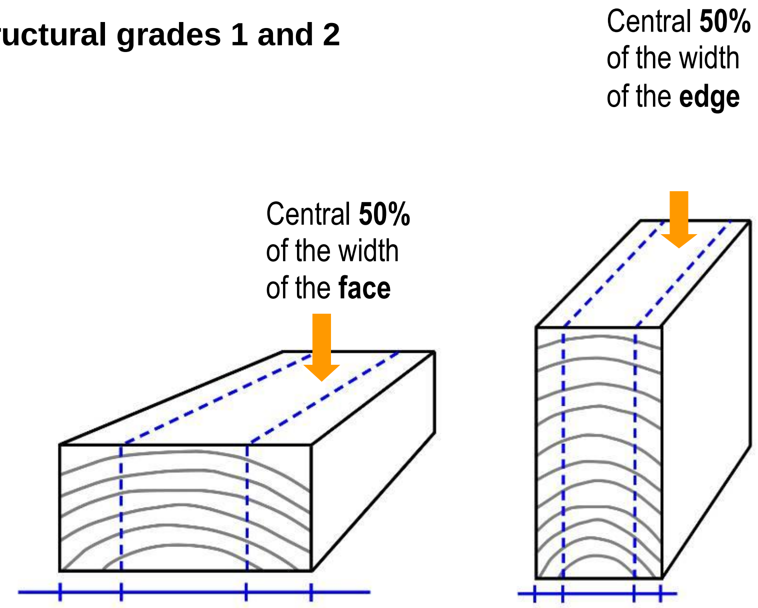
There are three basic types of knots in softwoods:

- **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' of the piece
- **Other knots**, comprising all knots that don't fall into the above categories.

Central region of the face and edge

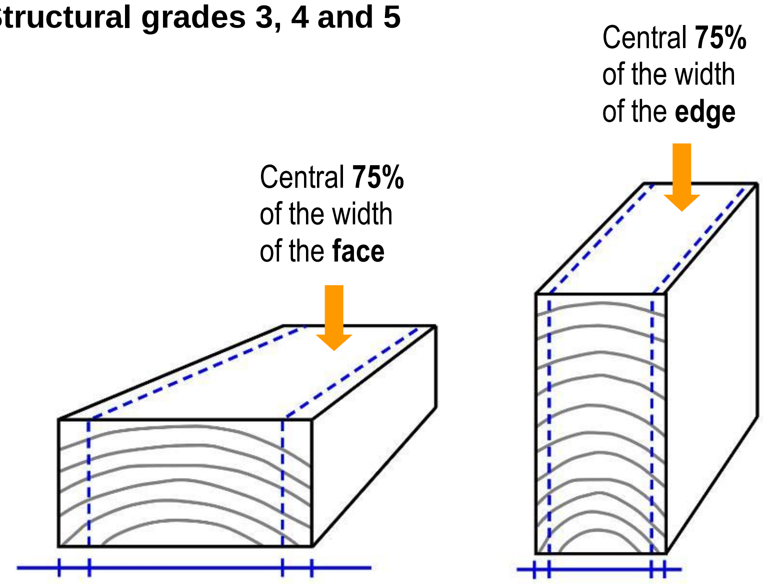
The central region of the face and edge varies, depending on the grade. In Structural grades 1 and 2 it represents 1/2 of the surface width, and in grades 3 to 5 it represents 3/4 of the surface. See the diagrams on the following page to see how you would visualise these regions on the face and edge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

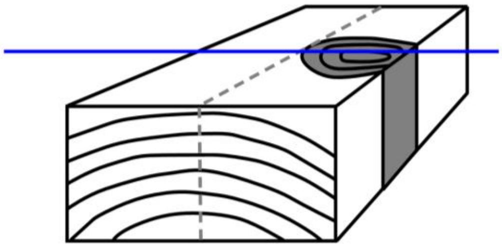
Assessing the size of knots

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 the 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.

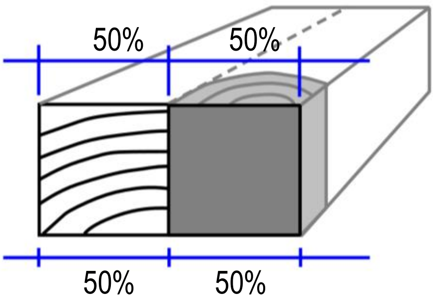
Have a close look at these three examples:

KAR of 50%



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

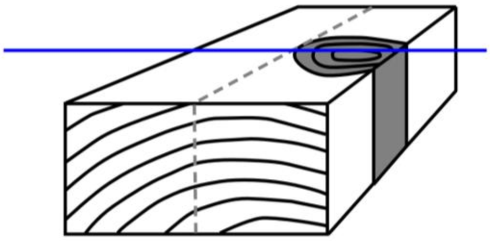
Dock through the knot at its widest point across the face.



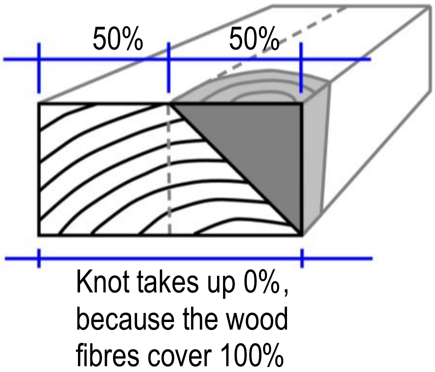
Because the knot is the same size on the top and bottom faces, it will take up exactly half of the cross section of the piece.

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.



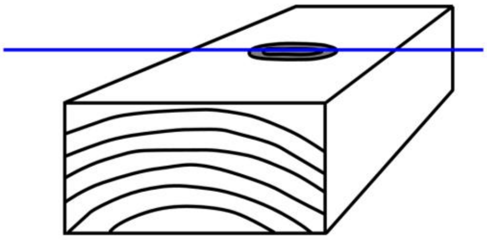
Now the knot only takes up a quarter of the end section.

Therefore, it has a KAR of 25%.

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

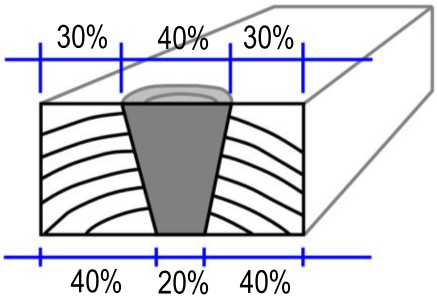
$$\frac{50\% \text{ (top)} + 0\% \text{ (bottom)}}{2} = 25\%$$

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.



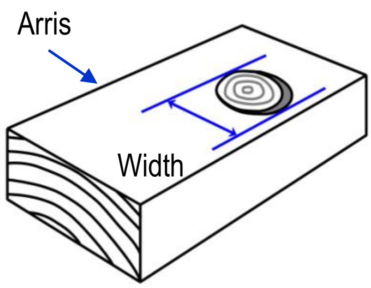
On the top face, the knot takes up 40% of the width. On the bottom face, it takes up 20%.

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



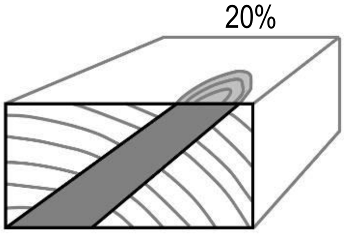
When you assess the surface width of the knot, take the measurement at its widest point, at right angles to the arris of the piece. Make sure you include any bark or voids associated with the knot.

Learning activity

Set out below is a summary of the KAR limitations for unseasoned 'west coast' (American) oregon, also called Douglas fir. Use this table to work out the grade of each of the knots shown below. Once you've decided on the grade, write the correct answer in the box for that question.

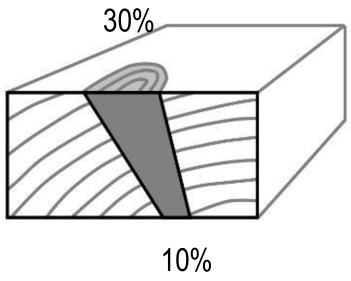
Remember that you'll need to work out what *type* of knot it is first, on the basis of its position, and then decide on the appropriate F grade.

Unseasoned North American oregon (D. fir) Maximum KAR	Structural Grade No 1	Structural Grade No 2	Structural Grade No 3	Structural Grade No 4	Structural Grade No 5
	F11	**F8**	**F7**	**F5**	**F4**
Face knots	Central 1/2 of face KAR 25%	Central 1/2 of face KAR 40%	Central 3/4 of face KAR 50%	Central 3/4 of face KAR 60%	Central 3/4 of face KAR 70%
Edge knots	Central 1/2 of edge KAR 25%	Central 1/2 of edge KAR 40%	Central 3/4 of edge KAR 50%	Central 3/4 of edge KAR 60%	Central 3/4 of edge KAR 70%
Other knots	KAR 15%	KAR 25%	KAR 30%	KAR 40%	KAR 45%



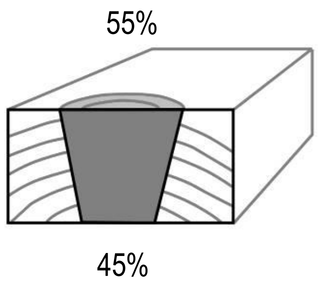
Knot 1

This knot takes up 20% of the width of the top face and 30% of the bottom face. What grade is it?



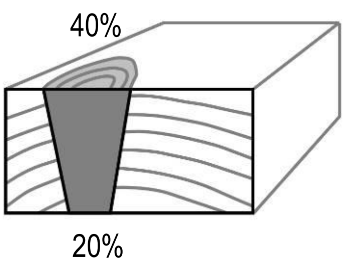
Knot 2

This knot takes up 30% of the width of the top face and is just within the central half of the face. It takes up 10% of the bottom face. What grade is it?



Knot 3

This knot takes up 55% of the top face width and its boundaries are within the central 3/4 of the face. On the bottom it takes up 45%. What grade is it?



Knot 4

This knot takes up 40% of the top face, but it's just outside the central 3/4 of the face. On the bottom it takes up 20%. What grade is it?

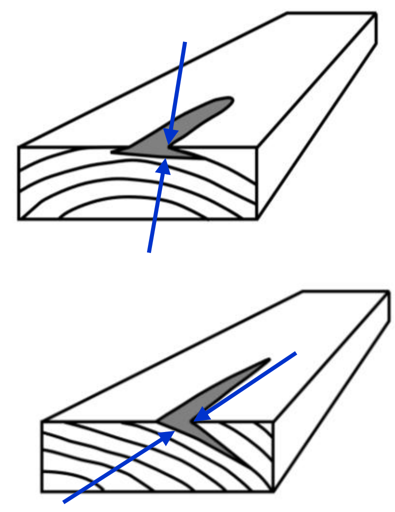
Resin, bark and overgrowths

Resin pockets, *bark pockets* and *overgrowths of injury* are 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.

- **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.



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 an up-and-down – or '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.

Learning activity

In seasoned radiata pine, resin pockets, bark pockets and overgrowths of injury are permitted in all grades (F8, F7, F5, F4) as long as the characteristic doesn't exceed the dimensions specified. For pockets and overgrowths that only appear on one surface, the dimensions are as follows.

Resin pockets, bark pockets and overgrowths of injury appearing on one surface only	
Maximum length	300 mm or 3 times the width of the surface (whichever is the lesser)
Maximum width	20 mm or 1/3 the width of the surface (whichever is the lesser)

A characteristic that is no bigger than these dimensions will therefore make an F8 grade, so if it was the worst defect in the board, the final grade for the piece would be F8. However, if the characteristic is larger than either of these dimensions, the board would need to be rejected from all grades. The only way to save the board would be to cut the defect out and re-grade the two shorter lengths.

For each of the resin pockets described below, decide whether the board is 'in grade' (i.e. F8) or 'out of grade' (i.e. reject).

1. On a 90 mm wide face, the resin pocket is 280 mm long and 15 mm wide.

2. On a 70 mm wide face, the resin pocket is 200 mm long and 10 mm wide.

3. On a 45 mm wide face, the resin pocket is 100 mm long and 12 mm wide.

4. On a 190 mm wide face, the resin pocket is 380 mm long and 22 mm wide.

Slope of grain

The piece of radiata pine in the middle (with the green stress-grader paint) shows a large *other knot*, and grain that swirls around it. This is 'local deviation' of the grain, and so is not classed as '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.

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.

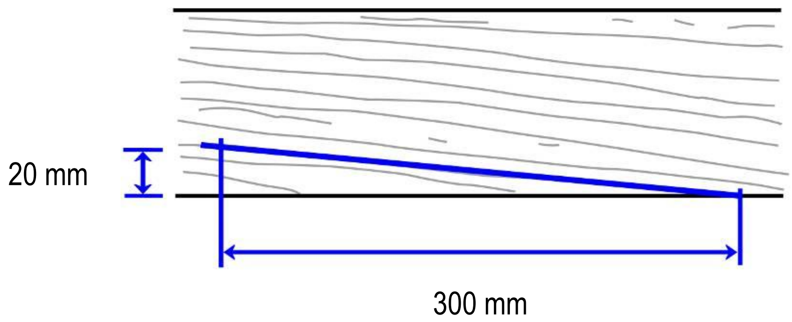
Measuring slope of grain

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 slop of grain will be 1 in 10.

The best way to measure slope of grain 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 below shows a rise of 20 mm to a run of 300 mm. Therefore:

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



Learning activity

Set out below are the slope of grain limitations for the five Structural grades. Work out how much the grain will rise over 300 mm for each of these ratios. Then get a piece of timber (or paper if you don't have any timber to hand) and mark out the measurements to see what the slope actually looks like.

If you've got access to plenty of timber, you might want to go looking for pieces that actually have that amount of sloping grain in them

Slope of grain limitations in structural softwoods				
Structural Grade No 1	Structural Grade No 1	Structural Grade No 1	Structural Grade No 1	Structural Grade No 1
1 in 15	1 in 10	1 in 8	1 in 6	1 in 5

Worked example:

Here's what the first calculation will look like:

Slope of grain: 1 in 15

Run: 300 mm

Rise: 300 ÷ 15 = 20 mm

Other characteristics

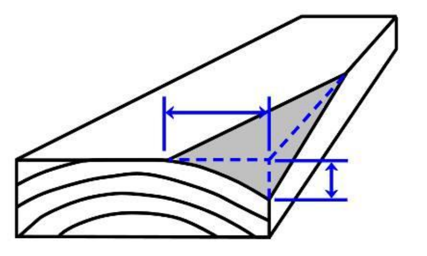
There are many other characteristics covered in AS 2858 that haven't been described in detail in this unit. Below are some more of the commonly occurring characteristics that you need to look out for.

Want and wane

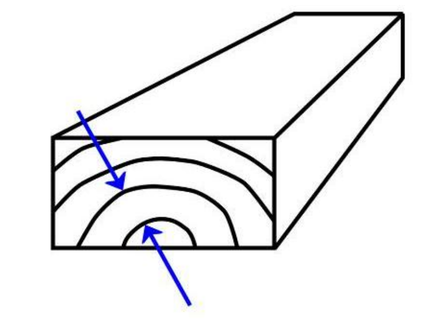
Want and wane are caused by different things, but because they have the same effect they're both measured in the same way.

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 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.

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

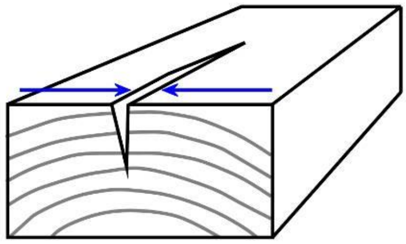
The wider the growths rings are apart, the lower the density is likely to be. There are certain restrictions in AS 2858 on the maximum distance between grown rings, depending on the grade. For more general information about growth rings, and the method for determining how close they are to the pith, when the pith is not visible in the piece, go to the chapter 'Growth rings' from the Learner Guide *Selecting timber*.

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.

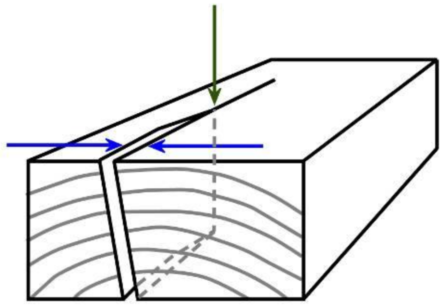
Checks



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 is called a *split*.

Splits

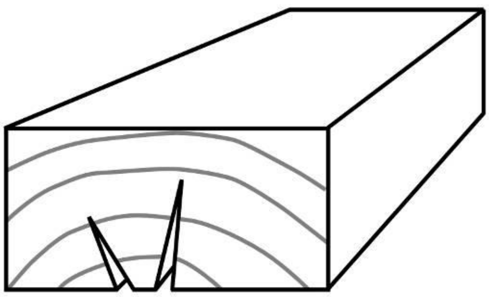


A split is a lengthwise separation of fibres that runs from one surface to another surface. It sometimes occurs when a drying check gets so bad that it goes right through the piece, and is particularly common on the ends of a board.

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 at right, 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.

Distortions in the board

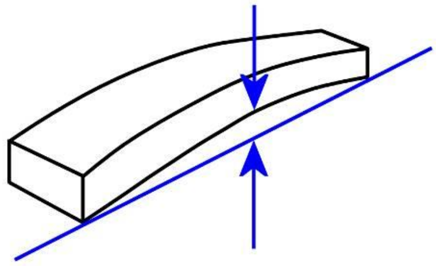
It's not uncommon for there to be a small amount of distortion in a board, especially if it dries unevenly or has a grain direction that moves around along its length. Small amounts of deviation from straightness and flatness can be pulled out of a board when it's fixed into position in the structure. 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.

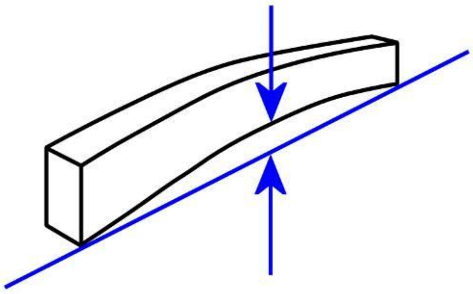
To measure bow, stretch a string line from one end of the board to the other, and measure the point of maximum deviation between the string line and the edge of the board.



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.

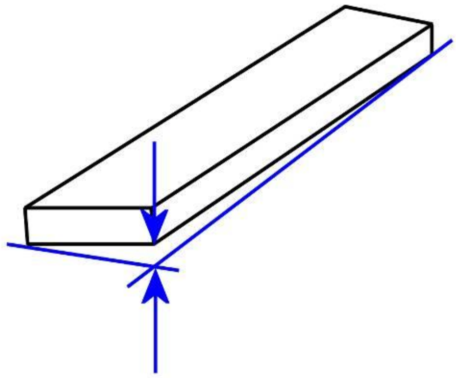
To measure spring, stretch a string line from one end of the board to the other, and measure the point of maximum deviation between the string line and the face of the board.



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.

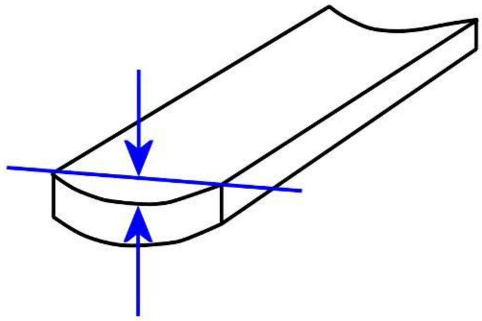


Note that a concrete floor is generally not flat enough to take an accurate measurement. In workplaces where there are no steel bench tops or other reliably flat surfaces, the only way to assess twist is to sight along the board and estimate the deviation.

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.



Learning activity

You're likely to find examples of most of the characteristics described in this lesson in your own timber racks or elsewhere on-site. Depending on the species you're working with, you may find examples of them all. Go outside and have a look for each of the characteristics listed below. If you've got a digital camera (such as in your mobile phone), take a close-up photo of each one. If you don't have access to a camera, note down the size, species and other details of the piece for each of the examples that you come across.

Characteristics:

Want

Wane

Wide growth rings within 50 mm radius of the pith

Surface check

Split (either within the body of the piece or on the end of the board)

Shake

Bow

Spring

Twist

Cup

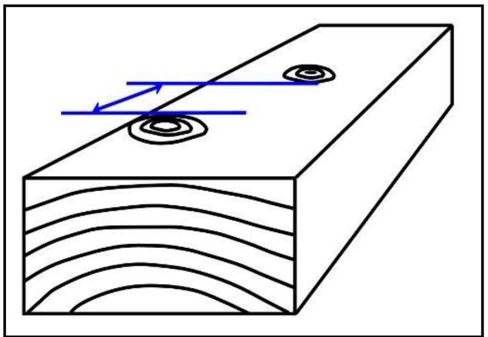
Combinations of characteristics

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.

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 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.

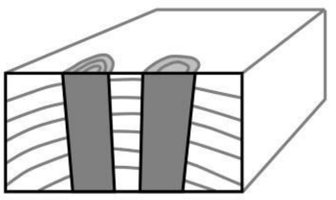
The most common combinations you're likely to come across are knots. However, any strength-reducing characteristics occurring within the 150 mm or twice the width need to be assessed in combination, including resin pockets, sloping grain, checks, splits and shakes. The only characteristics that aren't 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%

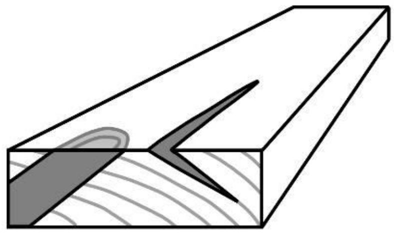
Face knot 2: KAR 25%

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

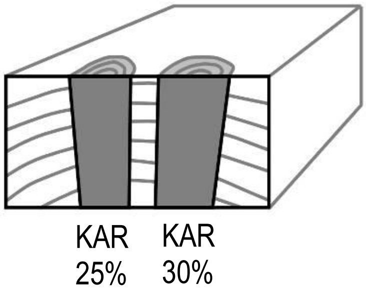
Combination: 90% of maximum allowed for the grade

Learning activity

Set out below is a summary of the KAR limitations for seasoned radiata pine. Use this table to work out the grade of each of the knots shown below. Once you've decided on the grade, write your answer in the box provided.

If you need to revise the definitions for the different types of knots, or the methods for assessing KAR, go back to the earlier chapter in this section on *Knots*.

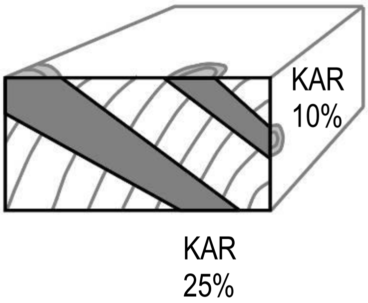
Seasoned radiata pine: maximum KAR	Structural Grade No 1	Structural Grade No 2	Structural Grade No 3	Structural Grade No 4	Structural Grade No 5
	F8	**F8**	**F7**	**F5**	**F4**
Face knots	Central 1/2 of face KAR 25%	Central 1/2 of face KAR 40%	Central 3/4 of face KAR 50%	Central 3/4 of face KAR 60%	Central 3/4 of face KAR 70%
Edge knots	Central 1/2 of edge KAR 25%	Central 1/2 of edge KAR 40%	Central 3/4 of edge KAR 50%	Central 3/4 of edge KAR 60%	Central 3/4 of edge KAR 70%
Other knots	KAR 15%	KAR 25%	KAR 30%	KAR 40%	KAR 45%



Combination 1

These two knots are both within the central face region for Structural grades 3, 4 and 5. Their KARs are 25% and 30%.

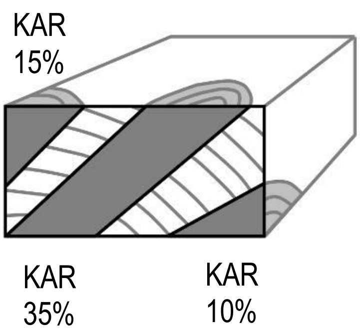
What grade will the combination be?



Combination 2

These two knots have KARs of 25% and 10%.

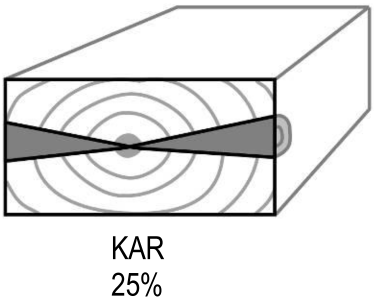
What grade will the combination be?



Combination 3

These three knots have KARs of 15%, 35% and 10%.

What grade will the combination be?



Combination 4

These two knots are both within the central edge region for Structural grades 1 and 2. Because they meet in the middle, you can treat them as one knot and call the total KAR 25%.

What grade will the combination be?

Task for Section 2: Assessing characteristics

Your task is to demonstrate your ability to apply the theory of visual stress grading to the practice of actually doing the job. You will be required to grade 100 pieces of timber while being observed by your assessor.

You may grade to one of the following Australian Standards:

- **AS 2858** – if you plan to carry out a full visual stress grade of the timber under the F grade system
- **AS 1748** – if you plan to apply visual over-rides to timber that has already been graded by a machine stress grader.

See your trainer or supervisor about organising the area and materials required for this assessment. You may either carry out the process on the production line, or alternatively grade the pieces one by one in an area set aside for the assessment.

Complete the grading sheet as you grade the 100 pieces. If you are working on-line at normal production speed, your assessor may fill in the sheet for you.

State whether you will be carrying out a full visual stress-grade of the timber or whether you be applying visual over-rides to the timber.