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Log Quality, Sawmilling Strategies and Seasoning Timber

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INTRODUCTION

The aim of these notes is to give you a basic understanding of:

- the key factors affecting log quality;
- some of the main considerations that influence milling strategies;
- the aims of timber seasoning.

I hope some of you are interested enough that you will follow up with some of the reading and contact me if you want more information.

LOG QUALITY

I will concentrate on sawlog quality, even though the bread and butter product from most farm plantations in the south west will probably be a chiplog for pulping or for a reconstituted panel product.

Any assessment of log quality has to be based on external (preferably measurable) characteristics (Clarke, 1989). What you are trying to assess is the probability of being able to mill a certain quantity of certain products from the log. By following some logs from a particular area or progeny through the sawmill and seeing how well they cut and what is cut from them, your judgement about log quality at the stump is likely to be a lot better.

Log quality assessment is hard enough when you can see the ends of the logs and even take to a lump or branch with a chainsaw. If you're trying to assess the standing tree, it can be very difficult.

Forest Products Commission WA has over 30 written specifications for different log products, ranging from high quality veneer or premium grade logs through to industrial firewood logs.

As an example, the basic components of a first grade jarrah log specification are its minimum **length** (2.1m), its minimum **diameter** underbark (200mm) and a minimum of 50% **millable wood** assessed on the worst end of the log.

Compare this with a (higher quality) hardwood veneer log which also has minimum **length** and **diameter** specifications, but has specific limits for **rot, heart, borers, shakes, shape, limbs, dry sides and gum**.

Or compare this with a first grade radiata or pinaster pine log which has to have a minimum **length** (4.8m), a minimum **diameter** (300mm), maximum **sweep**, is at least **25 years** old, has no **blue stain**, no abrupt **diameter changes** and no massive **knot whorls**.

Take note of the fundamental difference between the first grade jarrah and pine log specification. With the pine log, quality of the wood is just as important but doesn't need to be specified because virtually all plantation logs are sound. With the jarrah log, a huge variety of imperfections in the log is the norm and rather than give limits for all of them, a minimum millable wood specification is used to draw the boundary between first and second grade logs (50%) and between second and third grade logs (30%).

It is also important to remember that log specifications are only a basis for sale of those logs. Once the sawmiller has started to cut the log, then each cut will reveal much more information about the true log quality. With eucalypts in particular, the success of any milling operation relies heavily on the ability of the sawyer to make a good first cut and then modify subsequent cuts based on what is inside the log.

So, what is a perfect log?

Ideally, your log is about 500 – 700 mm in diameter (or even better, it's square!). This gives you the option to:

- produce a wide range of product sizes,
- quartersaw or backsaw,
- minimize wastage near the round edges,
- in reality, plantation logs larger than 450 mm diameter will be the exception.

Ideally, your log is long and straight, with minimal taper. Look back to the specification for a first grade pine log, which had to be at least 4.8m long with a maximum sweep of 60mm in any 3m length for the minimum (300mm) diameter log. And all logs are tapered (that's how trees grow), but obviously the more tapered the logs are the more short products you get.

Ideally, your log has minimal imperfections and damage:

- for pine logs, it's necessary to specify blue stain, abrupt diameter changes and knot whorls,
- knots come in two forms – green and dead. Green knots reduce the strength of timber because the straight grain is interrupted. Dry knots do the same, but there's often decay associated with them as well. For plantation logs, it's difficult to judge the knots status unless you know the silvicultural history,
- sloping grain reduces the strength of timber and also leads to problems when seasoning,
- pockets and veins of kino can reduce the strength of eucalypt timber. In some species (eg marri) it is difficult to cut sufficient structural timber from the majority of logs to make them worthwhile milling,
- borers can reduce the strength of timber,
- damage from fire or harvesting or handling or any other agency may reduce the recovery from a log or the strength of the products,
- in eucalypts, the heart can be brittle (not easy to detect prior to sawing) or decayed. The heart can also wander. Backsawing can minimize the impact of brittle heart on the products.

Ideally, your log stays straight once you start cutting. **Young eucalypts in particular** are prone to changing shape because of the longtitudinal stresses in the log. While storing the logs under sprinklers for a number of months may reduce the stresses in some of the worst logs, they are not eliminated completely and sawmilling strategies have to be designed to cope with these stresses.

Ideally, the wood in your log is of a uniform strength through the log. Unfortunately, this isn't the case. In both pine and eucalypts, the core of the log is juvenile wood which is of lower density (and therefore strength) and has more spiral grain (which also reduces strength). Juvenile wood also distorts more during sawing and is less stable in use.

As you can see, there's plenty for the sawmiller to grumble about. Unless you have a sense of humour and a positive outlook, sawmilling can be a depressing occupation.

But, even taking all these factors into account it is possible to cut reasonable quantities of serviceable timber from less than ideal logs. So, what is serviceable timber?

Even if no-one writes it down, a piece of timber selected to do a particular task is meeting a specification. Designing specifications for sawn timber, writing them down and then assessing parcels of timber to make sure they meet specifications regularly exercises a lot of very intelligent minds. As an example, I've picked out the main components of the specification for Structural Grade No 1 hardwood (visually graded) from AS 2082-1979 (Standards Assoc of Australia, 1979):

- free of fractures, termite galleries and end splits,
- knots not to exceed one seventh of the width,
- limits on borer holes, kino veins and kino(gum) pockets,
- limits on bow, spring and twist and on cupping (1mm per 50mm width),
- limits on checking (2-3mm wide),
- limits on sloping grain (1 in 12 jarrah, 1 in 15 other spp),
- limits on primary rot and included bark (very little),
- limits on wane, want and Lyctus susceptible sapwood,
- limits on heart and heart shakes,
- limits on tolerance (eg unseasoned, +/- 3mm for up to 200mm wide).

Of course, there are many more specifications and some very interesting approaches to assessing the strength of pieces of timber. There are also specifications for appearance grades of timber. WA has had a specification for two grades (prime and standard) of seasoned, sawn and skip-dressed WA hardwoods for a number of years. This specification is an adaptation of the structural specification. A more recent trend is the development of 'feature grade' specifications to reflect a growing demand for timber products which make features from what were once seen as imperfections eg kino veins, fire damage, knot holes. These new specifications will specify limits on these features to maintain minimum strength of the product and will possibly suggest or specify what can be done to fill or modify the various features.

And that's where I have to leave log quality.

SAWMILLING STRATEGIES

I would like to touch briefly on five topics in talking about sawmilling strategies:

- bandsaws vs circular saws,
- the merits of quartersawing and backsawing,
- sawing logs with growth stresses,
- breakdown and re-saw of logs,
- sawmill productivity.

1. Bandsaws vs Circular Saws

I'm not a sawmiller and if I were I might have a strong preference for bandsaws or circular saws. Most millers seem to have a strong preference one way or another. I think that it's horses for courses: bandsaws have certain advantages and do some tasks in a mill better, while circular saws have other advantages. I say, choose the type of saw you're comfortable with and then make sure it is operated to peak performance.

Much of the debate about the merits of bandsaws is based on the narrower kerfs achievable with these saws. However, narrower kerf circular saws are now available and you have to ask yourself whether half a millimeter in kerf is significant. If you are routinely cutting each piece to within half a millimeter of your chosen dimension, the answer is yes. If not, look at factors other than kerf first.

Bandsaws can accommodate high feed speeds, but they are more costly to install than circular saws, require more setting up and more skilled saw doctoring and are less likely to stay sharp when sawing defective logs.

2. Quartersawing and Backsawing

Quartersawing may be the favoured pattern of cutting for a number of reasons. One reason, which is done with sheoak, is that it exposes the pattern of the medullary rays in the face of the cut board. Another reason, common in SE Australia for many years and sometimes practiced in WA, is to minimise the effects of shrinkage of the face of the board during drying (radial shrinkage is significantly less than tangential shrinkage).

Backsawing may be favoured for different reasons. For one, the product recovery is usually significantly higher than for quartersawing, particularly when the logs are less than 500 mm diameter (this depends on the products being cut of course). Another reason is that boards cut away from the core of the log are usually of higher quality and can be segregated from the boards cut near the core more easily with a backsawing strategy. Another reason, particularly relevant when sawing young eucalypt logs is that growth stresses appear in the product as bow when backsawing, which is much easier to deal with than spring, which is what you get from quartersawing.

3. Sawing Logs With Growth Stresses

When logs with longtitudinal growth stresses are sawn those stresses - which are usually balanced in the log - get out of balance and cause the pieces to bend. The miller then has to deal with the (bent) cut off flitch and the rest of the log which is not bent as dramatically as the smaller piece cut off the log, but can easily be out of straight by 10-20 mm even though the saw cut was straight.

It is relatively easy to deal with the cut off piece with a re-saw strategy that forces subsequent cuts to follow the curve of the piece. That's not to say it's not a skilled operation – it is – or that it's always done properly – it isn't.

Making subsequent cuts on the bent log remainder is not so straightforward. In fact, some of the strategies for breaking down logs with growth stresses try to avoid the problem occurring. These include cutting flitches of both edges at the same time – so the centre cant stays straight – or using a frame saw to cut the whole log into boards at one pass. There are disadvantages of both of these methods, not least of which is that the log cannot be taper sawn.

If a single flitch has been cut from a log leaving a log remainder which is distorted, then the best method of cutting parallel faced pieces off is to use a line-bar carriage. The line-bar, which is mounted on the feed side of the saw, acts as both a sizing mechanism and as a solid surface against which the log is pushed. The hydraulics of the log carriage must be able to progressively apply lateral pressure to the part of the log that is approaching the saw, so that the saw cut follows the curved face of the log.

If the sawyer cannot somehow make the saw follow the curve, then the only alternative is to make a straightening cut, which wastes timber and time.

4. Breakdown and Re-saw of Logs

Most sawmilling operations have a distinct place where the logs are broken down, followed by a variety of re-sawing options. It is difficult to be anything but general without going into detail about the different types of systems.

As a rule, **log breakdown** systems should:

- have a saw or saws that are capable of handling the size and quality of logs sawn and cutting accurately and at sufficient speed.
- have an efficient and safe means of loading logs onto the system and taking the product to the re-saw systems,
- allow the sawyer to orientate the log for the best first cut,
- in the case of eucalypts in particular, allow the sawyer to select the second and subsequent cuts on the basis of what the previous cuts revealed,
- in the case of logs with growth stresses, be able to cut uniform boards working from a curved face,
- allow the sawyer to remove from the log and then discharge waste material from the mill,

As a rule, **re-saw** systems should:

- be able to efficiently segregate the pieces from the breakdown system into the various products categories,
- be able to produce the products that are the best match of the timber and the sizes which can be sold for the highest price,
- transfer different grade or waste material efficiently to the right location in the mill,
- in the case of timber with growth stresses, being able to follow the curved face with subsequent cuts.

5. Sawmill Productivity

To say that any sawmill needs to be set up and run productively may seem an obvious when every aspect of growing, harvesting, handling and processing must be efficient if we are going to survive financially. What I mean is that sawmilling is an expensive operation that is not romantic after the first hour or easy to do well. It is also tempting to focus too much on the percentage recovery of product rather than the value of product or on saving transport costs by milling at the stump without taking into account the efficiencies of a properly set up mill.

SEASONING

In this brief introduction to seasoning timber, I'd like to:

- Outline the reasons for drying timber,
- Illustrate why pine and eucalypts are so different to dry,
- Clarify what the objectives of drying should be,
- Emphasise the three main factors which need to be controlled to achieve these objectives.

More detailed information can be found in the Australian Timber Seasoning Manual (AFRDI, 1997)

1. Reasons for Drying Timber

Timber is dried because:

- It becomes lighter and stronger,
- It is more stable in service when it's moisture is in balance with the air,
- It machines better,
- It takes a finish better,
- It glues better,
- It has better insulating properties,
- It is more resistant to most forms of biological attack,
- It has a greater heat value.

2. The Different Drying Characteristics of Pine and Eucalypts

Radiata pine for structural use can be dried successfully from green in less than five hours at temperatures around 180-200°C. This is being done commercially, not just experimentally.

In case this statement doesn't amaze you, from a fifty cubic metres of timber in a kiln, around 25 tonnes of water is being drawn out of the wood, evaporated into the kiln and then exhausted to the air as steam.

The reason this is possible is that there are tiny gaps in the walls of wood cells called pits (they are microscopic, you can fit about 200 of them side by side per millimeter). These pits help moisture diffuse laterally in the wood. In the case of pine, they are numerous enough and open enough for moisture to be converted to steam in the wood cells and then push outwards to the surface of the timber.

Eucalypts have pits between cells as well but moisture cannot move through these pits nearly as well as in pine so drying eucalypts, particularly from green (70% moisture) to 20% is slow, taking weeks at best.

3. The Objectives of Good Timber Drying

Anyone drying timber should have three objectives:

- achieving a uniform moisture content,
- minimising degrade from drying,
- doing the job in a reasonable time.

Uniform Moisture Content

It's important you know what moisture content you need to dry timber to. To know that, you should know where the timber is going to end up in service. For example, for joinery in Kalgoorlie or and air conditioned building in Perth, you might aim for 6 %, whereas for the same product you only need to dry it to 12% for use in Albany (Brennan and Pitcher, 1995).

Six percentage points of moisture content might not sound a lot when your starting moisture content is around 70%. But getting to 12% can be difficult enough without and getting down to 6% and then keeping it there is even harder.

Having chosen a moisture content of say 10%, you should then aim to have all parts of all the pieces within 2% of that target (AFRDI, 1997 p23). That's not unrealistic, but it's not easy to achieve. If you are seasoning timber and want to minimise problems caused by movement of that timber in service, then aim for that target.

Minimising Degrade from Drying

Drying timber is like most systems: garbage in, garbage out. Don't confuse timber degraded from drying with timber that shouldn't have been selected for drying in the first place.

The types of drying degrade you can get can be grouped into three categories:

- checks
- distortion
- stresses

Checking can be on the ends of the piece, on the surface or internal. One of the major causes of surface checking is the rapid drying of the surface which is not balanced by sufficient moisture moving from the inside of the piece of timber. The tangential face, which shrinks the most, is more susceptible to checking.

Distortion of timber includes cupping, twist, spring and bow and sometimes more than one of these in a piece. Restraining the timber by proper strip stacking and the use of weights will reduce the amount of this type of degrade, though you may have to look at the selection of timber and the way it is cut to eliminate it altogether.

Stresses caused by drying are often in balance and may not show themselves unless the piece is re-sawn or machined deeply, particularly on one side. They can be detected and prevented in most cases if you know what your looking for and how to test for stresses.

Doing the Job in the Minimum Time

When you just dry a cubic metre of a special batch of timber for your own use, the fact that it takes a year or two to be thoroughly seasoned mightn't seem too long. If you're making a habit (or business) of drying timber, the time taken becomes a critical factor in the cost of the operation. In the highly competitive business of producing radiata pine structural timber, if you're not using high temperature kilns to dry pine in less than a day and keeping drying costs down around $25 per cubic metre, then your competitor (who may be in South America) is getting a jump on you. By contrast, drying eucalypts will cost five to eight times that much per cubic metre.

4. The Three Factors that Need to be Managed for Good Drying

If you are drying timber, there are three factors which will be crucial to success

- Heat,
- humidity,
- airflow.

Heat

Evaporating moisture requires energy and to dry timber, you have to deliver that energy to the surface of the timber. The temperature of the wood also has a large bearing on the rate that moisture will diffuse through wood.

Humidity

The humidity of the air surrounding the timber determines how much and how easily moisture can be evaporated from the surface. Sometimes you will want to raise the humidity to reduce the rate of drying, while at other times you will need to lower it.

Airflow

The air that flows past each and every surface of timber being dried is what brings heat to the wood and takes evaporated moisture from it. Without a flow of air, the progress of drying slows drastically. Without even airflow, drying is not uniform.

If you examine any drying system - be it an air drying yard, a low tech kiln or kilns worth millions of dollars, the success of drying will depend largely on being able to monitor and manage these three factors. And whole books are written about how to do that.

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