

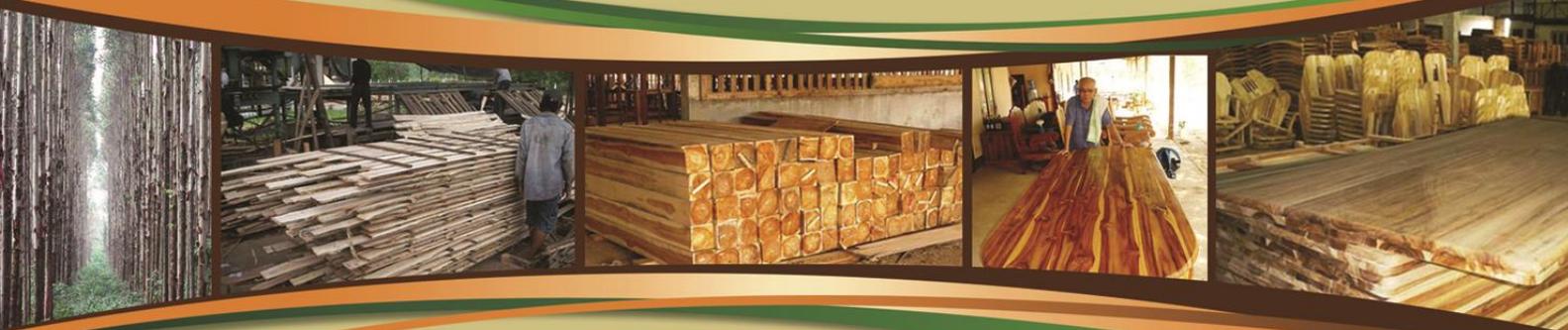


# ENHANCING KEY ELEMENTS OF THE VALUE CHAIN FOR PLANTATION GROWN WOOD IN LAO PDR

## Sawn timber grading in Lao PDR

**Product grading manual: rules and  
recommendations**

**Adam Redman 2016**



**VALTIP2**

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## Introduction

This research was undertaken as a component of Activity 2.5 of Objective 2 (To increase returns to processors and smallholders through improved efficiencies of the primary processing sector) in the ACIAR co-funded aid project FST/2010/012 *Enhancing key elements of the value chain for plantation-grown wood in Lao PDR*.

The aims of this report are to:

1. Recommend standardised sawn timber product grading rules applicable to SMEs in Laos PDR.
2. Provide a user friendly manual including best practice measurement, visual examples and training summary tables.

## Background

This project component builds on the ACIAR project FST/2005/100 Value Adding to Laos Plantation Timber Products (VALTIP), which was completed in January 2001. This project made significant achievements in enhancing local capacity in timber testing and processing and facilitated improvements in the range and value of wood products in nine wood manufacturing enterprises. As a result of this previous project, a number of key elements of the value chain which required intervention to increase returns to smallholders, wood processors and manufacturers were identified and were used as the foundation for developing this project. One of the key elements was to improve the value adding of plantation grown wood through technical improvements in wood processing and manufacturing. A number of activities were developed to meet this key objective, one of which was to develop and/or improve product grading and implement the rules in industry cluster companies. The development of product grading rules forms the basis of this report.

The purpose of grading sawn/dried timber is to sort material into groups desired for best utilisation and price/value category. Ideally, grading should provide a fair price for sawn timber, give the buyer confidence in the quality, sort material for best in-service use and separate material into quality groups in which buyers and sellers can agree on value. The price/value relationship is set not only by the aesthetics of the wood, but also by the demand for the species. The value of sawn timber is usually determined by its species, size and quality. Normally clear wood free of defects costs more however natural defects or 'features' of timber are being promoted and demanded in the marketplace.

There are two main types of sawn timber grading:

1. For appearance products
2. For structural products

The grading rules proposed here are for appearance products, particularly for furniture components as this is more applicable to the current Laos PDR timber processing industry.

Sawn timber grading standards used internationally are usually relevant for either hardwood or softwood species, or sometimes a particular species or species group. The grading rules proposed here apply to Laos hardwood species only.

## International rules

Many countries have established standards or non-standardised grading rules used to grade sawn timber for appearance products. Different manufacturers using non-standard sawn timber grading rules classify the quality differently depending on the company and the customer's wishes, as well as on the wood species and type of sawn timber or the planned use.

The commonality between all sawn timber grading classifications is the use of a set of grading criteria used to classify material into different grade classes. Grade criteria can include natural wood defects/features or man/machine made defects caused by the sawing and drying processes or handling. Wood defects also called features are important because they affect the quality and value of wood, its appearance and performance in service.

Natural wood defects include defects such as the number and size of knots, type of knots, natural splitting, holes, insect attack, decay etc. Man and machine made defects can include want, splitting due to drying and distortion due to processing and drying etc. Grade classes also differ between grading standards and guidelines but are usually assigned either a letter alphabetically (i.e. A, B, C etc.) or numerical class (i.e. 1, 2, 3, etc.), where the best grade class is 'A' or '1' where subsequent grades (in alphabetic or numerical order) are usually of progressively lower quality and value.

Sawn timber grading systems vary internationally, however their application is the same and they all identify grade limiting defects, measure the defects, determine size and species requirements and assign a grade. The following is brief summary of a number of international and Australian grading rules and standards:

### **Australian and New Zealand standard 2796.3: 1999**

The purpose of this standard is to provide product and grade requirements for furniture timber sawn or milled from hardwood. The standard also specifies tolerances for boards intended as feedstock for furniture components.

The grades specified in this standard are primarily based on features and desired aesthetic appearance. Three grades are provided as follows:

#### **Select grade**

The highest quality sawn timber grade displaying a small number of small sized and sparsely spread features.

#### **Medium feature grade**

Medium quality grade displaying a medium number of medium sized with a higher frequency of features than select grade.

#### **High feature grade**

Displays a higher frequency, size and type of features than the other grades.

This standard, unlike many other grading standards and rules also contains limits on sawn wood distortion (twist, bow, spring and cup). Distortion limits are governed by the sawn wood dimensions (i.e. width, thickness and length).

## **USA rules: 2014**

The USA hardwood grading rules are non-standardised but are widely used by other countries such as Russia, Canada and South America. The rules were first developed with the formation of the National Hardwood Lumber Association (NHLA) in USA in 1897 and have since been revised on a number of occasions. The rules include standard dimensions for sawn hardwood timber components as well as a number of grades based mostly on the percentage of clear wood and the number of component faces to be graded. The rules also contain specific allowable limits for different features depending on species.

The NHLA rules were designed with the furniture market in mind to provide a measurable percentage of clear, defect-free wood for each grade. The upper grades provide the user with long clear pieces, while the Common grades are designed to be re-sawn into shorter clear pieces.

The upper grades include FAS (First and Seconds), FAS/1F (FAS-One-Face) and Selects, are mostly suitable for long clear mouldings, joinery and furniture where a large percentage of clear wood is required.

The Common grades are No. 1C (number 1 Common), No. 2AC (number 2A Common) and No. 3AC (number 3A Common) are likely to be suitable for cabinets, some furniture parts and plank and strip flooring. The name grade simply designates the percentage of clear wood in the board, not the overall appearance.

The NHLA grading rules allow the following features and characteristics in the clear cutting percentages for all grades and are therefore not considered as defects: heartwood and sapwood, grain swirl (burl), mineral discoloration, streaks, sticker mark that can be removed via planing.

The NHLA grading rules do not allow the following characteristics in the clear cuttings for all grades and they are considered as defects: bark pocket, bird peck, checking, decay, unsound knot, sound knot, split, sticker stain, wane, insect attack and pith.

The rules allow some allowances for certain defects for certain species where those defects are more inherent in those species.

## **European standard EN 975-1:1999**

The European grading rules applies specifically for oak and beech species. It contains three sets of rules; one each for unedged boards( boules), edged boards and square beams. Unedged timber has four grades titled in decreasing quality order: BA, B1, B2 and B3. Similarly edged timber has six grades titled: FA, F1a, F1b, F2, F3, F4, and square beams have three grades: PA, P1, and P2.

For each grade four common criteria are specified and they differ between grades depending on size, frequency and presence. They include grain slope, knots (type, size and frequency), sapwood (amount) and heart shakes. Other features that differ between grades and are specified as either

allowed or not are grain fineness, ring shake, bark pocket, stain, borer holes, curly grain sapwood, decay, red heart, wane and loose knots.

## **Guyana timber grading rules: 2002**

The Guyana timber grading rules (GTGR) are based on the quality and quantity of defects in a piece of wood. Grading is carried out according to the type of intended product. Permissible defects are allowed for each grade and a piece of timber is rejected if it has more defects than are allowed for the product.

The GTGR are a comprehensive set of grading rules for a wide variety of wood products including:

- Sawn baulks
- Hewn squares
- Round timber piles
- Sawn timber for building and construction
- Sawn timber for dressing and furniture manufacture
- Dressed products from seasoned timber
- Railway sleepers/crossings
- Round transmission poles
- Telegraph and electric power cross-arms
- Fencing posts
- Shingles
- Fence staves
- Hardwood logs

Only the rules presented for 'sawn timber for dressing and furniture components' will be discussed in this report as they are most relevant. These grading rules are comprised of four grade qualities, namely: Prime, Standard, Factory-suited, Mill-run. The following is a brief description of the purpose of each grade:

### **Prime**

Intended for the highest quality products.

### **Factory-suited**

A quality equal or better than prime but cut to dimension specified by the customer. For use in furniture, parquetry, etc.

### **Standard**

Very good quality for normal use in building, joinery and utility furniture construction.

### **Mill-run**

Moderate to low quality for normal use in building, joinery and utility furniture in local markets.

The standard grade feature criteria include: minimum length, loose knots, sound knots, shakes, sapwood (Lyctus and not Lyctus susceptible) sloping grain, pin holes, grub holes, drying checks, brittle heart, decay, holes and bark pockets. The standard also included restrictions on board distortion, namely bow, spring and twist.

# Proposed sawn timber hardwood grading system for Laos PDR

## Introduction

The aims of this grading system are to provide a benchmarking system for sawn hardwood quality, to enable wood processors to ensure that the sawn wood and products will meet the requirements of their customers, and to match their sawn timber to the best product utilisation.

The proposed grading system is based heavily on the Australian / New Zealand Standard 2796.3 as this standard is currently in use by some processors in Laos PDR and the National University of Laos (NUoL) Faculty of Forestry research staff, lecturers and students are trained to use this grading standard. Additionally this standard was chosen as it included grading for distortion, which is removed from many other grading systems. Some criteria have been removed to make the grading system more applicable for grading small plantation hardwoods and the minimum length for distortion allowed has been reduced to account for the prevalence of the small dimension furniture component commodity in Laos PDR.

The guidelines are issued as a first edition and may be superseded or refined in the future if the needs of the stakeholders change, the nature of the resource changes, or if new products and markets are developed that require a different suite of grade descriptors than those provided here.

## Grade criteria

The following grade criteria are included in this proposed grading system:

### Features

- Tight knots
- Loose knots
- Knot holes
- Borer holes
- Tight gum veins
- Loose gum veins
- Gum pocket
- Overgrowth of injury
- External checks
- Natural stain
- Process induced stain
- Want
- Wane
- End split
- Decay
- Termite galleries
- Lyctus susceptible sapwood

### Distortion

- Bow

- Spring
- Twist
- Cup

## Definition and measurement of grade criteria

### Knots and knot holes

Knot and knot hole diameter is measured in the direction parallel to the width of the board as shown in Figure 1. Knots are graded based on a combination of the diameter of the largest knots, the width of the knot in relation to the board width, and the number of knots on a board surface area.

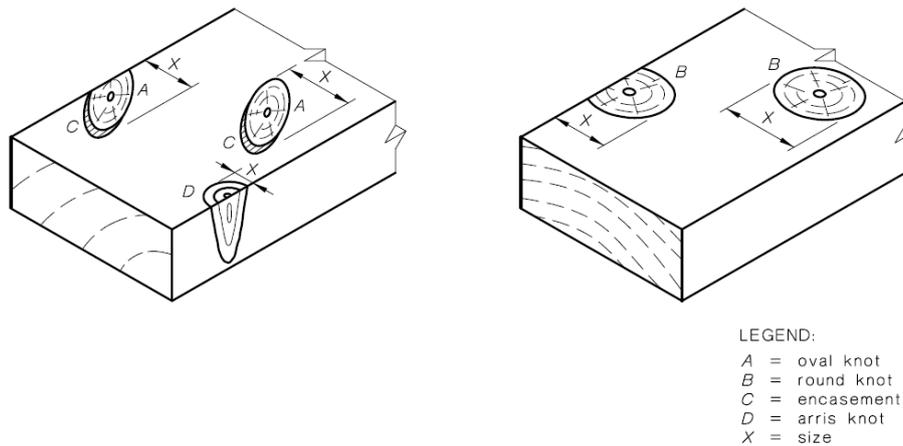


Figure 1. Measurement of knot and knot hole diameter – image from AN/NZS 2796.3:1999

### Sound knots

A sound knot is a knot that is solid across its face, as hard as the surrounding tissue and free from decay (Figure 2).



Figure 2. Example of sound knots

### Loose knots

A knot which is not held firmly in place by growth and which cannot be relied upon to remain in place in the piece (Figure 3).



(a)



(b)

**Figure 3. Bark encased loose knot (a) and removed loose knot (b)**

### ***Knot holes***

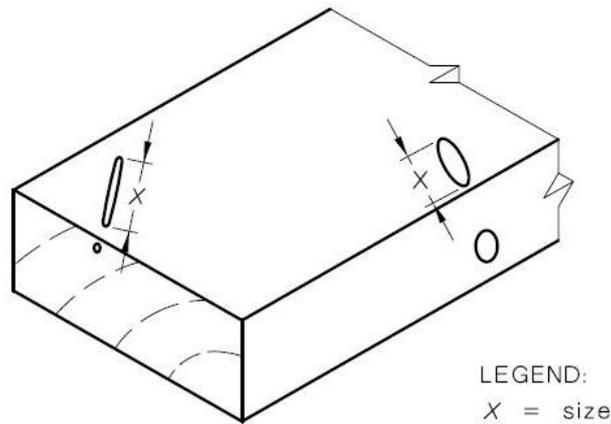
The hole left over after a knot has fallen out or been removed (Figure 4).



**Figure 4. Knot hole**

### **Holes other than knot holes**

Holes that are not knot holes include holes caused by borers or machinery. Unlike knots their diameter is measured where it is largest as shown in (Figure 5). Holes are graded based on a combination of the diameter of the largest holes, the number of holes on a board surface area and the number of holes per 1 m board length.



**Figure 5. Measurement of borer and machine holes – image from AN/NZS 2796.3:1999**

Figure 6 shows an example of borer holes.



**Figure 6. Example of borer holes**

### **Gum pocket, gum vein, bark pocket and overgrowth of injury**

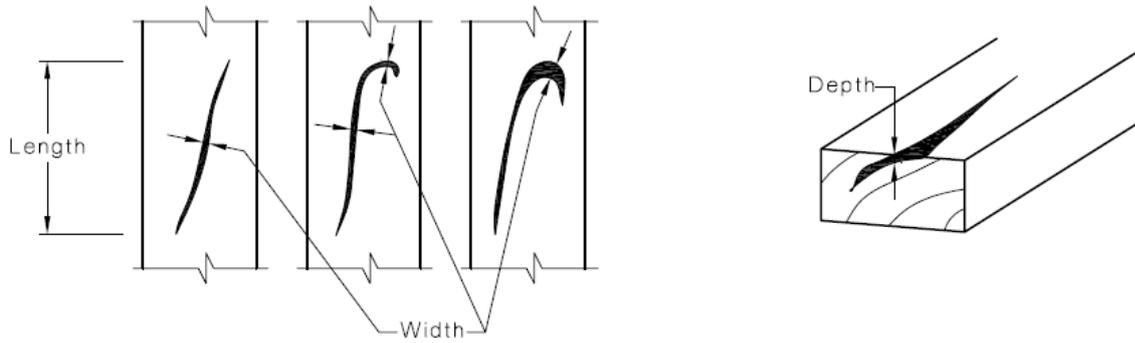
The width of gum pockets, gum veins, bark pockets and overgrowth of injury is measured at the widest point (Figure 7). In some cases the length and depth is also required for grading. They are graded based on a combination of the width, length, depth and percentage of board length.

Gum pockets are a cavity that contains gum (also known as kino) (Figure 8). Gum is a natural exudation produced in trees as a result of fire or mechanical damage.

Gum veins are a deposit of gum between growth rings which may be bridged radially at short interval by wood tissue. Tight gum veins are those where the gum is adhered to the wood tissue and is solid and not flaky. Loose gum veins are usually bigger than tight gum veins and the gum is brittle and flaky (Figure 9).

Bark pockets are a patch of bark partly or wholly enclosed in the wood. Not to be confused with the bark associated with an encased knot (Figure 10).

Overgrowth of injury is discoloured areas usually associated with deviated grain, gum and bark where the wood has overgrown from an injury, branch stubs or fire (Figure 11).



**Figure 7. Measurement of gum pocket, gum vein, bark pocket and overgrowth of injury. – image from AN/NZS 2796.3:1999**



**Figure 8. Gum pocket**



**Figure 9. Gum vein**



Figure 10. Bark pocket



Figure 11. Overgrowth of injury

### Splits and checks

Splits and checks are measured by their width and length (Figure 12) and graded accordingly.

Splits are a longitudinal separation of wood fibres extending through a piece of timber from one surface to another (Figure 13).

Checks are a separation of the wood fibres confined to the surface of a piece of timber (Figure 14).

Knot checks are checks located within knots (Figure 15).

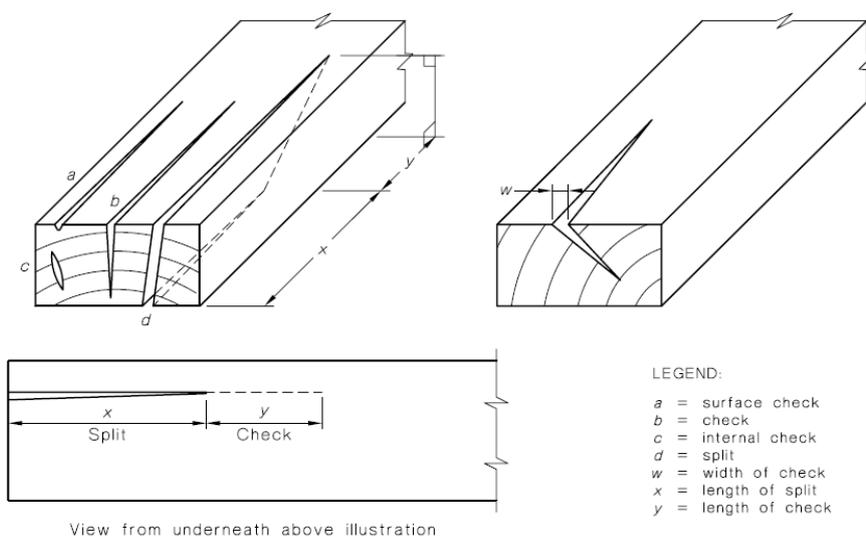


Figure 12. Measurement of splits and checks – image from AN/NZS 2796.3:1999



**Figure 13. End split**



**Figure 14. Checks**



**Figure 15. Knot checks**

## Want and wane

Want and wane is only permitted on concealed surfaces and is measured and graded by width and length (Figure 16). Want is parts of the board that are missing either through processing or damage (Figure 17). Wane is the absence of wood from the r surface of a piece of timber indicated by the presence of the original underbark surface with or without bark (Figure 18).

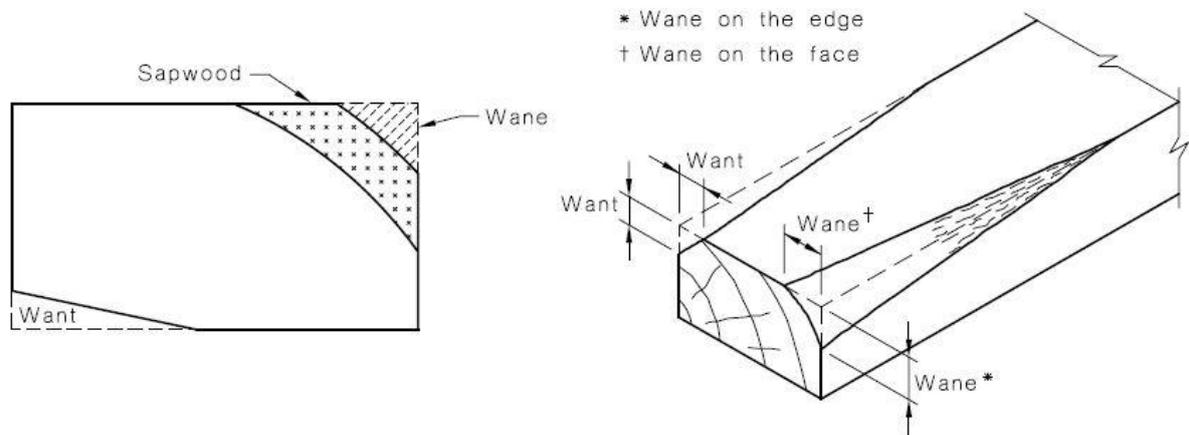


Figure 16. Measurement of want and wane – image from AN/NZS 2796.3:1999



Figure 17. Want



Figure 18. Wane

## Decay

Decay is decomposition of wood by fungi (Figure 19). It is measured by its presence and is not permitted for any grade.



Figure 19. Decay

## Stain

Stain is areas of colour differing from the average colour of the surrounding piece or from the colour normally associated with the piece and occurring in either streaks or patches (Figure 20). It is measured by its presence. There are some allowances for natural stain but unnatural stain is not permitted for any grade.



Figure 20. Stain

### Sticker stain

Sticker stain refers to a discoloured or stained area that runs across the width of a board and is in the same location where a sticker was located during drying (Figure 21). It is measured by its presence and is not permitted for any grade.

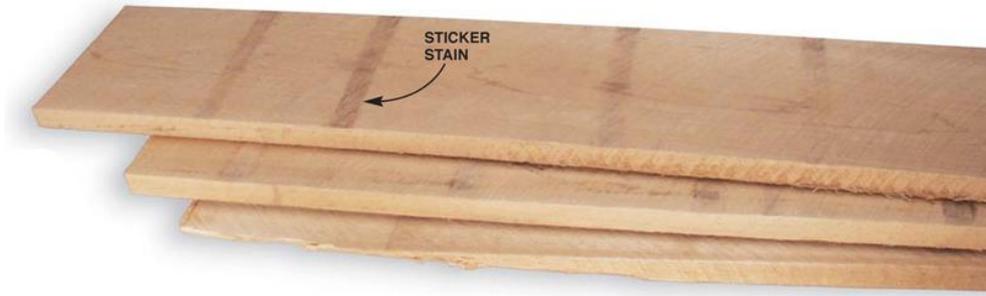


Figure 21. Sticker stain

### Lyctus-susceptible sapwood

Lyctus-susceptible sapwood refers to species whose sapwood is susceptible to be attacked by the lyctus beetle (Figure 22a). Teak and many eucalypt species are susceptible. The beetle produces a series of small circular holes in the sapwood (Figure 22b). It is measured by its presence and is not permitted for any grade.



(a)



(b)

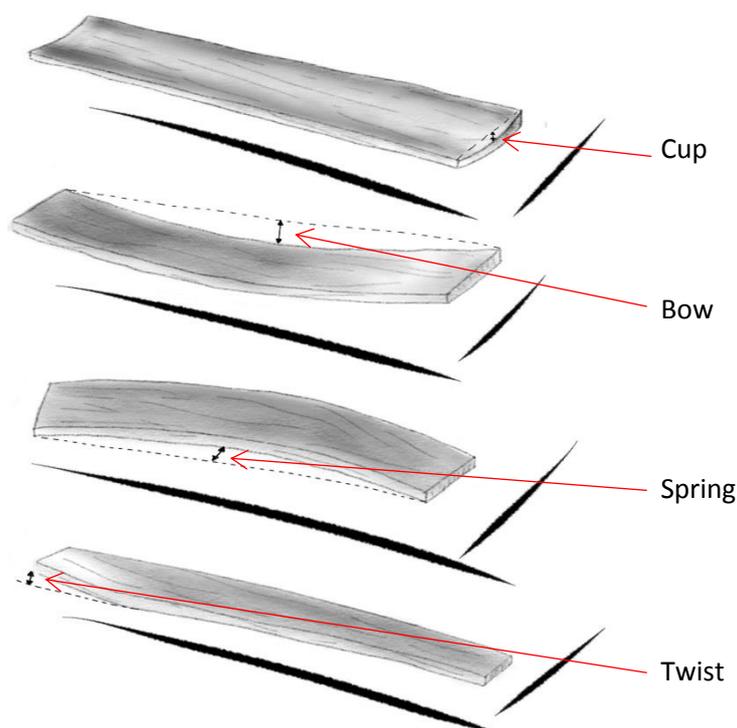
Figure 22. Lyctus beetle (a) and sapwood attacked by lyctus beetle (b)

## Distortion

Distortion is a deviation from flatness in boards as a result of stresses and uneven shrinkage. The types of wood distortion include:

- Bow – distortion along the length of the face of the board
- Spring – distortion along the length of the edge of the board
- Cup – distortion across the width of the face where the edges are higher or lower than the centre of the board
- Twist – distortion where two ends of the board do not lie in the same plane.

Distortion is measured at the largest point of deformation for each distortion type as illustrated in Figure 23.



**Figure 23. Distortion measurements**

Distortion is graded based on permissible limits of the measurements made as per Figure 23. The permissible limits for bow are governed by the board's thickness and length, for spring by width and length, for twist by length and for cup by width.

The limits are based on those provided in AS/NZS 2796.3:1999 except the limits have been adjusted to accommodate a minimum board length of 0.3 m. Standard AS/NZS 2796.3:1999 limits board length to 1.2m. The smaller minimum board length presented here is proposed to accommodate small dimension furniture components that are prevalent within the Laos industry.

## Grade classification

The following grading system (next two pages) incorporates three grades similar to AS/NZS 2796.3:1999. In order of highest to lowest quality/value they are Select, Medium Feature, and High Feature grades. For a board to meet Select grade classification all grade criteria must meet Select grade classification. For instance, if all criteria meet Select grade except one criteria meets Medium Feature only, then the board is classed as a Medium Feature board. If a board displays a criteria outside High Feature grade it is considered a reject board. Special consideration may be given to reject boards depending on company and client specifications.

Some criteria have more than one rule that needs to be adhered to. For instance, for a board to meet Select grad board for borer hole criteria, all borer holes must be  $\leq 2$ mm wide with a maximum number of 6 holes allowed in a 100 x 100 mm area and 12 holes in a 300 x 300 area. If it doesn't meet this then the board is graded for borer holes to see if it meets Medium Feature grade and so on.

The grading system can be used to grade on any number of board face depending on the its intended application. For instance, depending on the application, if only one face is exposed (i.e. flooring) then the best appearance wide face is chosen and the board is graded using just that face. If the board is fully exposed then the board should be graded using the worst quality face.

Depending on product demand and customer requirements, boards can be upgraded by docking out defects (such as splits, knots etc.) to produce shorter boards of better appearance quality.

The grading rules for defect (feature) and distortion are provided below. They are in a format that is intended to be printed back to back as a training tool, or singular to hang as a poster in a sawmill grading area for reference.

<b>Criteria</b>	<b>Select</b>	<b>Medium Feature</b>	<b>High Feature</b>
<b>Tight knots</b>	≤ 15 mm wide, ≤ 1/4 board width	≤ 40 mm wide, ≤ 1/3 board width	≤ 50mm wide, ≤ 1/2 board width
<b>Loose knots and knot holes</b>	Not permitted		Same for holes
<b>Knot checks</b>	Not permitted	≤ 2 mm wide	≤ 3 mm wide
<b>Holes – borer, termites etc.</b>	≤ 2 mm wide maximum 6 in 100 x 100 mm area maximum 12 in 300 x 300 mm area	≤ 3 mm wide maximum 20 in 100 x 100 mm area maximum 30 in 300 x 300 mm area	≤ 3 mm wide maximum 20 in 100 x 100 mm area maximum 30 in 300 x 300 mm area ≤ 10 mm wide 3 per 1m length > 10 mm not permitted
<b>Tight gum vein</b>	≤ 2 mm wide, ≤ 250 mm long ≤ ½ total board length (added)	≤ 60 mm wide, ≤ 1 m long ≤ 2 mm deep	≤ 2 mm deep
<b>Loose gum vein</b>	Not permitted	Not one surface to another ≤ 3 mm wide ≤ 1/5 total board length (added)	
<b>Gum pocket and Over growth injury</b>	Not permitted	Not one surface to another ≤ 10 mm wide, ≤ 50 mm long ≤ 2 mm deep	Not one surface to another ≤ 15 mm wide, ≤ 75 mm long ≤ 2 mm deep
<b>Checks - external</b>	≤ 1 mm wide, ≤ 250mm long (each)	≤ 2 mm wide, ≤ 250mm long (each)	≤ 2 mm wide, length unlimited
<b>Stain - natural</b>	Slight (up to consumer)	Unlimited	
<b>Stain – other including sticker mark</b>	Not permitted		
<b>Wane and wane</b>	Exposed surface = not permitted Concealed surface ≤ 1/3 of surface width, ≤ 300 mm long		
<b>End split, decay, termite galleries</b>	Not permitted – splits can be removed		
<b>Lyctus susceptible sapwood</b>	Not permitted		

# Distortion criteria

## Limits for Bow

Product type	Length (m)	Thickness				
		15 mm	19 mm	25 mm	35 mm	45 mm
Dressed boards for furniture components	0.3	0.5	0.5	0.5	0.5	0.5
	0.6	1	1	0.5	0.5	0.5
	1.2	2	2	1	1	1
	1.8	5	4	2	1	1
	2.4	10	6	3	2	2
	3.0	15	10	5	2	2
Sawn boards for furniture components	0.3	1	1	1	1	1
	0.6	2	1	1	1	1
	1.2	6	5	4	3	2
	1.8	13	11	9	7	5
	2.4	22	19	16	13	10
	3.0	35	30	25	20	15

## Limits for Spring

Product type	Length (m)	Width				
		60 mm	80 mm	90 mm	120 mm	140 mm
Dressed boards for furniture components	0.3	0.5	0.5	0.5	0.5	0.5
	0.6	1	1	1	1	0.5
	1.2	2	2	2	1	1
	1.8	5	4	4	2	1
	2.4	10	7	6	3	2
	3.0	15	12	10	5	2
Sawn boards for furniture components	0.3	1	1	1	1	1
	0.6	2	2	2	1	1
	1.2	6	5	5	4	3
	1.8	14	12	11	9	7
	2.4	25	21	19	16	13
	3.0	40	33	30	25	20

## Limits for Twist and Cup

Length (m)	Twist per 25 mm width (mm)		Cup, per 100 mm of width (mm)
	Up to 25 mm thickness	Over 25 mm thickness	
0.3	0.5	0.5	1.0
0.6	0.5	0.5	
1.2	1	0.5	
1.8	1.5	1.0	
2.4	2	1.0	
3.0	2.5	1.25	