Wood Basics

Products, Properties, Terminology, & Specification

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Learning Objectives

- Participants completing this activity will be able to:
  - Describe the essential timber and wood product types
  - Describe the essential properties of timber and wood products
  - Specify timber and wood products
- For architects - AACA Competencies:
  - Design
  - Documentation

This presentation

- Timber's primary characteristics
- Product types
- Sizes
- Grade & grading
  - Structural
  - Appearance
- Specification

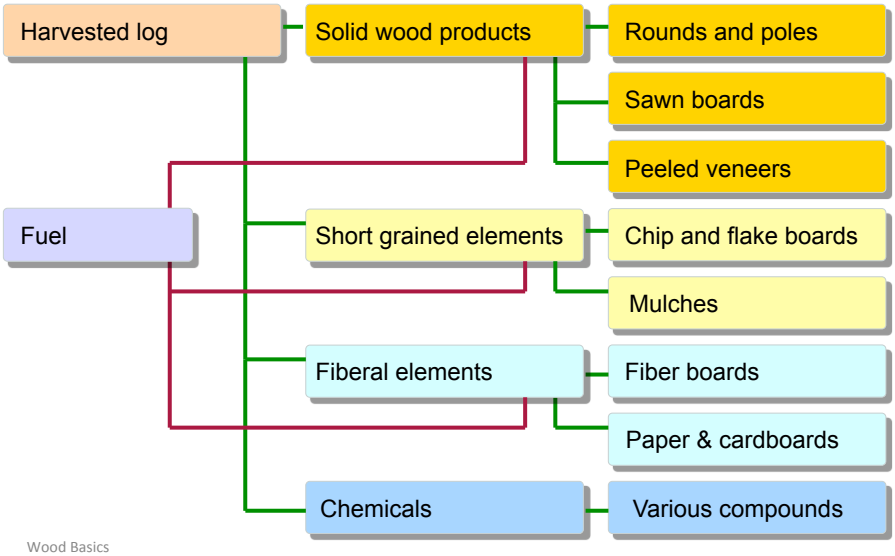
Vertical board cladding

Timber as a material for design - Basics

The forest yields logs

Wood Basics

… that are converted by various techniques…



Wood Basics

… into products ready for fabrication…

… into imaginative elements or..

… utilitarian applications of varying scale.

Material Properties - Basics

Timber is a natural material

Natural: *existing in or caused by nature; not man-made*

- Timber is a natural material, drawn from the wood in trees.
- The tree determines the timber's character.
  - Its species.
  - Form and growth of the wood in the tree over time.

Regrowth in a native forest

Major timber species

Hardwoods

- NSW/Qld – blackbutts, ironbarks, spotted gum, stringybarks,
- Victorian/Tasmanian – Tassie oak, ash species
- WA – jarrah, karri
- Imported – oak, merbau/kwila, belian

Softwoods

- Australia plantation pines – radiata, hoop, slash
- Australian native - cypress
- Imported – radiata, baltic pine, spruce, Douglas fir, SPF, western red cedar

Major timber species

Plantation timbers

- Radiata pine is most commonly used plantation grown timber for wood products in Australia
- Advantages:
  - light-weight
  - easy to handle and cut
  - can be finished with a variety of coatings and stains
  - easily treated to extend durability
  - high strength to weight ratio
  - reliable supply and low cost
- Other plantation pines: Slash, Caribbean
- Plantation hardwoods: Supply of quality material is limited.

Timber is hygroscopic

Hygroscopic: *the ability to lose or gain moisture content with fluctuations in environmental humidity.*

- When harvested, timber holds a significant volume of water.
- After seasoning, timber absorbs or loses moisture to remain in equilibrium with the surrounding atmosphere
  - As it absorbs moisture, ***it expands***.
  - As it loses moisture, ***it shrinks***.
- The timber's moisture content (MC) is critical for structural and appearance applications.

Hardwood drying in racks

Moisture content: structural

Seasoned (S) timber

- Also called kiln-dried (KD), the timber's MC is between 10% and 15%
- Minimal additional shrinkage - dimensionally stable
- Remain straight - little twisting, cupping or bowing
- Well suited for painting.

Unseasoned timber

- Also called "green", the timber's MC is greater than 15%.
- Prone to shrinkage and movement.

Moisture content: appearance

The recommended MC varies for each product but generally:

- Interior:
  - between 9% and not more than 14%
- Exterior:
  - between 10% and not more than 18%

Unseasoned timber is generally unsuitable for appearance applications.

Timber is variable (anisotropic)

Anisotropic: *having physical properties that have different values when measured in different directions.*

- It also varies with its original location in the tree, and the tree's age, source, and species.

Tree growth and the character of wood

Zones of wood

Bark
• A protection layer. New bark is made continually with portions falling off each year.

Pith / heart
• cells from the original sapling or growing tip

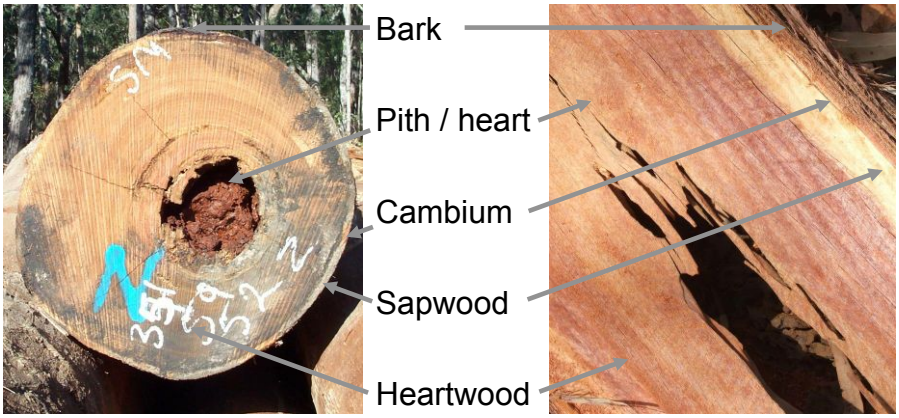
Cambium
• growth cells that created wood cells on the inside face and bark cells on the outside

Sapwood
• newest wood on the outside areas of the stem that transports nutrients between the root and the leaves

Heartwood
• older wood cells filled with extractives and other material to increase durability and support for the tree.

Wood`s structure and variability 1

Zones of wood



Wood' s structure and variability 1

Timber is biodegradable

Biodegradable: *capable of being decomposed by bacteria or other living organisms*

Wood can be broken down by:

- weathering
- fungi (or decay).
- insects and termites.
- marine organisms.

The impact of these mechanisms vary with:

- exposure to hazard.
- the nature of the wood.

Lyctid borer attack in sapwood

Timber's weathering

- The greying and minor cracking of timber due to *mechanical* or *chemical* breakdown of the surface by:
  - light,
  - the action of dust and sand, and
  - Shrinkage and swelling due to moisture content changes.
- The breakdown rate is slow with effects often limited to the surface.
  - ~ 0.1 mm per year depending on species and board orientation.
- Weathering affects appearance, the performance of finishes; and eventually, decay rate.

Timber's decay

- Decay is the decomposition of wood by fungi. Decay rates vary with:
  - The wood's character
  - Its moisture content (20% MC and above)
  - The ambient temperature (~ 5° to 60°C).
- It can occur most readily in timber kept regularly moist.
  - It tends to attack the moisture-permeable end-grain most vigorously.
- Decay hazard is often assessed *above ground* and *in-ground contact*.

Timber's resistance to hazards

- Timber resists hazards by
  - its natural durability and
  - any applied treatment.
- Natural durability:
  - varies with species and
  - is rated in durability classes *in-ground contact* and *above-ground*

Timber's natural durability

Class	Probable in-ground life expectancy *(years)*	Probable above-ground life expectancy *(years)*	Example species
1	Greater than 25	Greater than 40	Ironbark, Tallowwood
2	15 to 25	15 to 40	Spotted gum, Blackbutt, WRC
3	5 to 15	7 to 15	Brush box, Southern blue gum, Messmate
4	0 to 5	0 to 7	Vic ash, Radiata pine, Douglas fir

All *sapwood* is rated Class 4.

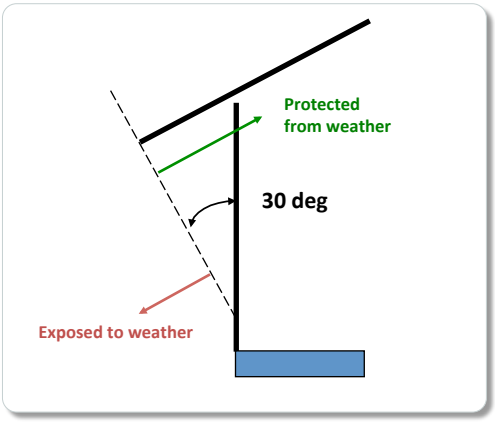
The ratings in this table are based on expert opinions and the performance of the following test specimens:

(a) In-ground: 50 × 50 mm test specimens at four sites around Australia.

(b) Above-ground: 35 × 35 mm test specimens at eleven sites around Australia.

Durability: Protection from weather

AS 1684: Protected from weather



Treatment extends the product suite

- Material susceptible to biodegradation can be treated with preservative chemicals to provide a reliable service life.
  - The toxicity and amount of chemicals retained governs the protection level.
- The target chemical retention is set for the intended Hazard Level.
- As the chemicals are carried in a liquid, wood's permeability limits the effectiveness of treatments.
  - It is very hard to reliably achieve the target retentions in heartwood.

Treatment classes

Class	Suitability	Biological hazard	
H1	suitable for H1 hazard environments – **indoors, protected**	Borers Only	
H2	suitable for H2 hazard environments – **suitable for all internal use**	Borers and termites	
H3	suitable for H3 hazard environments – up to **above ground external use**	Decay borers& termites	
H4	suitable for H4 hazard environments – up to **in contact with dry ground**	Severe decay, borers & termites	
H5	suitable for H5 hazard environments – up to **all in-ground uses**	Very severe decay, borers and termites	
H6	suitable for H6 hazard environments –up to **marine uses**	Marine wood borers and decay	

Major conventional treatment

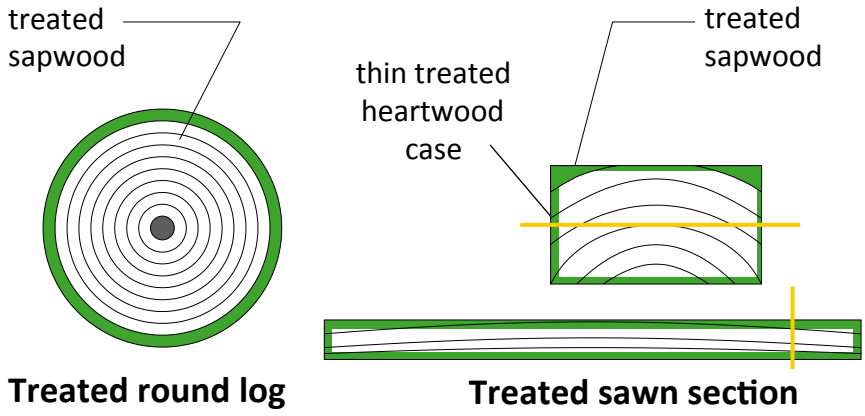
TYPE		HAZARD LEVEL					
		H1	H2	H3	H4	H5	H6
Water	Boron	☺	☺				
	CCA	☺	☺	☺	☺	☺	☺(1)
	Copper Azole	☺	☺	☺	☺	☺	
	ACQ	☺	☺	☺	☺	☺	
Solvent	LOSP	☺	☺	☺			
Double	CCA + Creosote						☺

(1) Southern waters only

Preservative treatment

- For hazard levels H1 – H6 preservative must penetrate:
  - 100% of the sapwood
  - 0 – 20mm of the heartwood
- The exception is for timber framing South of Tropic of Capricorn - Hazard level H2F

Penetration after treatment



Treated round log **Treated sawn section**

Penetration after pressure treatment

The wood's permeability limits treatment retention.

- Heartwood in hardwood is very hard to treat reliably.
- Heartwood in softwood may retain treatment but below the levels required for standard compliance.

Key product types

Limits on timber products

- Timber products are limited by:
  - The form and size of the log
    - Size constraints impose on recovered pieces
  - The directionality of its key properties
  - Its structural consistency *(or variability)*

Primary reduction process

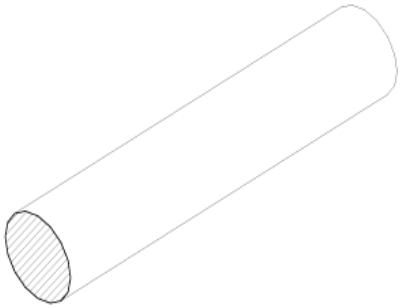
Sawing


Slicing


Peeling

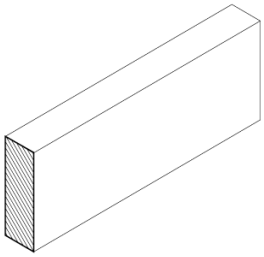
- The log is ***broken down*** into a hierarchy of elements, governed by value.
- Solid wood processing can only convert a portion of logs to the most valuable elements.
- The remainder is channeled into other, less valuable element streams.

Timber rounds - poles



- Natural or shaved round timber used with or without preservative treatment.
- A valuable market for forest thinnings.

Sawn timber & scantling



- Hard or softwood boards cut from logs and usually dried.
- This is a versatile material used for moulding, frames and exposed structures.
- Board size is restricted by log size and required cutting patterns.

Engineered wood products

Laminated Veneer Lumber (LVL)

Engineered wood products: glulam

Small section timbers can be glued together into large structural elements that may be used in architectural structures.

Glulam made to AS 1328 Glued-laminated structural timber

Other wood products

I-beams

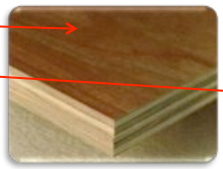
Cross laminated timber

- Multiple layers of solid section timber glued together into panels with the grain direction *alternating* between layers.
- The panels are custom-made to the panel's intended function.
- Currently, imported into Australia but not produced here.

Wood panels

Panel products

- Plywood
- Hardboard
- Particleboard
- MDF
- Veneer


Fabrication: Doors and windows


Appearance timbers can be fabricated into external or internal joinery elements.

Fabrication: Wall frames

Fabrication: Nail-plated products

Steel nail-plates can convert sawn boards into versatile truss elements designed for specific projects.

Product sizing

Sizing: Terminology

Timber is ordered by actual or nominal dimensions

- Nominal dimensions
  - approximate size of timber based on its unseasoned condition and rough dimension that it was originally cut to.
    - e.g. a sleeper of nominal size of 200 x 50 mm will have actual dimensions less than this. This is to account for shrinkage and any machining that may have occurred
- Actual dimensions
  - are actual timber size

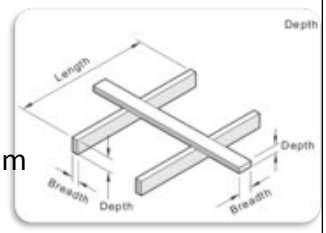
Sizing: Terminology

Generally;

- Seasoned timber - uses **actual** dimensions
- Unseasoned (green) timber– uses **nominal** dimensions

Sizing: Terminology

- **Timber dimensions**
  - Usually nominate the depth first followed by breadth
  - "Depth by breadth"
    - Studs and joists – 90 x 35 mm
    - Wall plate and battens – 45 x 70 mm
    - Joist – 190 x 35 mm
  - In North America it's reversed



Sizing: Availability

Availability

- Seasoned structural timber usually only available in 35 mm and 45 mm breadth for both hardwood and softwood
- Check with local suppliers before specification, especially outside metro area

Sizing: Pine Sizes

Width (mm)	Thickness (mm)			
	35	45	70	90
35	-	45	70	90
45	-	-	70	90
70	35	45	70	-
90	35	45	70	90
120	35	45	-	-
140	35	45	-	-
170	35	45	-	-
190	35	45	-	-
220	35	45	-	-
240	35	45	-	-

Sizing: Hardwood (seasoned) sizes

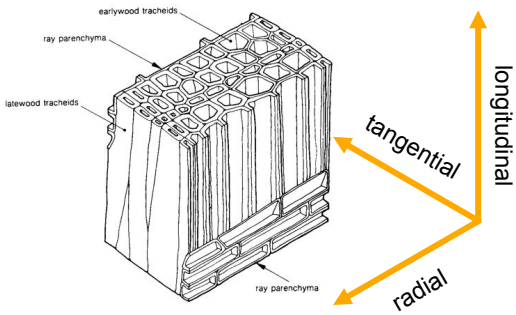
Width (mm)	Thickness (mm)	
	35	45
70	35	45
90	35	45
120	35	45
140	35	45
170	35	45
190	35	45
220	35	45
240	35	45

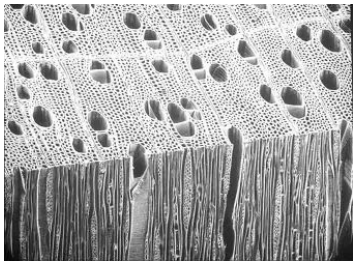
Sizing: Hardwood (unseasoned)

Width (mm)	Thickness (mm)				
	25	38	50	75	100
50	x	x	x	75	100
75	x	38	50	75	100
100	x	38	50	75	100
125	x	38	50	75	100
150	x	38	50	75	100
175	25	38	50	75	x
200	x	38	50	75	x
250	25	38	50	x	x

Product strength performance and grading

Cell structure and directionality





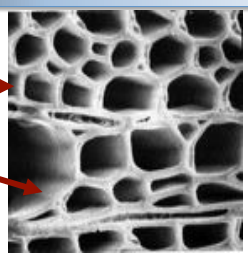
Vessels and fibers in birch
Source: http://www.swst.org/teach/set2/struct1.html

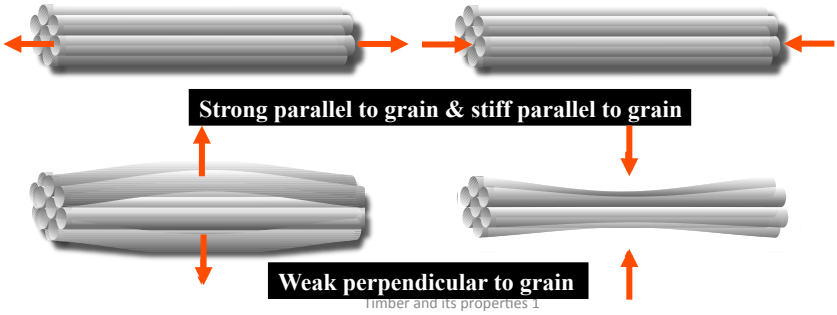
- Wood is anisotropic. Its properties vary radially, tangentially, and longitudinally
- The cell structure is primarily longitudinally arranged tubes.

Cell structure, strength & stiffness

Timber's strength is related to:

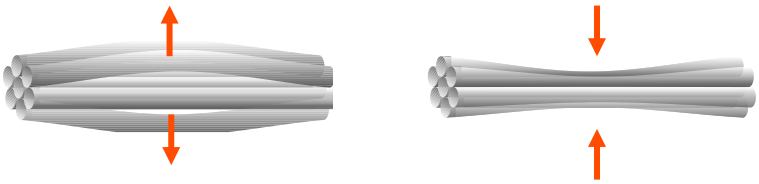
- Properties of the cell structure
- Cell size and direction





Relative strength

Tension & compression along the grain: 10 units

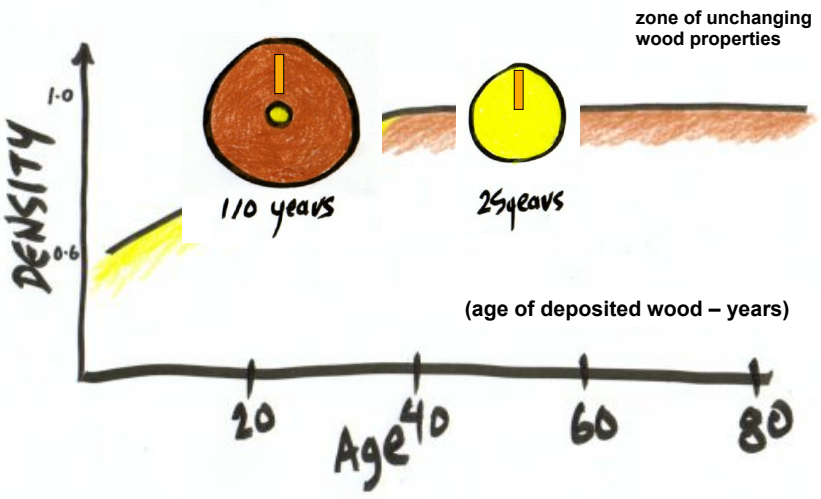


Tension & compression across the grain >1 units

Key structural properties

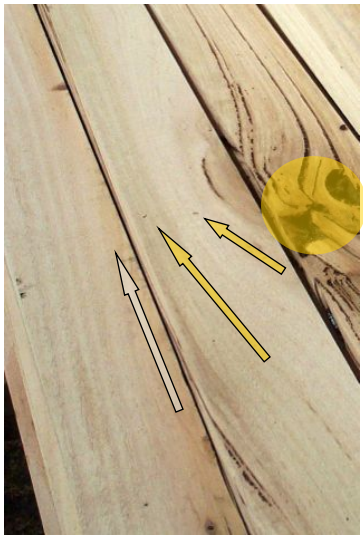
- **Strength** *(when it breaks)* and **stiffness** *(how much it bends)* values are influenced by:
  - moisture content,
  - grain structure of the species,
  - slope of grain in the piece,
  - other features in the piece.

Wood variation with age



Strength-reducing characteristic

- Knots: *part of a branch*;
- Grain direction: *sloping or irregular*;
- Check and shakes: *small surface cracks or splits;*
- Bark and heart or pith
- Gum vein, resin pockets
- Insect attack; and
- Others.



Grade & Grading

- In practice, grading involves separate assessment of:
  - The properties of the timber in the piece against grade criteria
  - The quality of the piece's form as a board or sheet against specific tolerances for warp, wood quality, etc.

Grade & Grading

Structural stress grades

- F Grades
  - e.g. F5, F7, F8, F17, F27
  - Visual and/or mechanical testing process
  - Applies to all softwood, hardwood, plywood and rounds
- MGP (Machine graded pine) Grades
  - e.g. MGP 10, MGP 12, MGP 15
  - Machine tests stiffness of timber
  - Applies only to radiata, slash, hoop, Caribbean pine. Some spruce is available
- GL grades – Glulam grades
- LVL and I-beams,
  - unique properties to each manufacturer – manufacturers grade

Grade & Grading

Non-structural grades

- Merchant (merch) “grade”
- Merch was a structural grade in 60’s / 70’s
- No longer recognised as a grade

Grade & Grading

Structural stress grades

- Characteristics that affect stress grade:
  - Sloping grain
  - Knots
  - Fractures
- Some companies also sort on appearance after stress grading (e.g. for pergola framing timbers)

Grade & Grading

Structural stress grades

Main stress grade limiting characteristics

Slope of grain

Live knots

Dead knots

Grade & Grading

Structural stress grades

Lesser stress grade limiting characteristics

Core wood – pith – weaker wood – lower load capacity

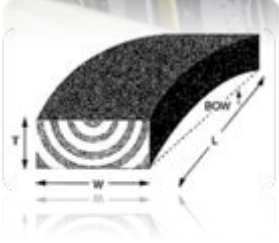
Surface checks / fractures – only a problem if they become splits

Grade & Grading

Structural stress grades

Lesser stress grade limiting characteristics

Wane - absence of underbark timber
Want – absence of timber other than wane



Bow – curvature along the face Spring – curvature along the edge

Grade & Grading

- **Structural stress grades Identification**
- MGP stress grade is marked with either ink marks, stamp, end tag or sticker
  - -Ink marks may occur every 1.2 m
- Do not rely on the mill colour marks for grade identification
- Rely on actual grade marking or grade on delivery docket
- If there is more than one grade mark on the timber, ALWAYS go with lowest grade

Grade & Grading

Structural stress grades - Important

- Grading applies at time of grading
- So if:
  - Forklift splits / tears a chunk out of timber; or
  - Timber is re-sawn into smaller dimensions
- Member no longer has any stress grade
- Timber needs to be regraded or considered as non-structural

Grade & Grading: Appearance

Appearance grade products

- Flooring and light decking
- Lining / panelling
- Handrails, balusters, balustrades, stringers, and treads
- Dressed boards, joinery and trim: mouldings, architraves, skirting boards, shelves, door and window frames
- Cabinets: built in cupboards, benches, furniture
- Cladding, fascia

Grade & Grading: Appearance

Appearance grades

- Many common descriptions are meaningless unless it is accompanied by a grade description
- e.g. in Australian Standard for softwood (AS 4785) and hardwood have appearance grades
  - Softwood (AS 4785)
    - clear, appearance, select, standard or utility
  - Hardwood (AS 2796)
    - select, medium feature, high feature

Grade & Grading: Appearance

Wood Solutions™ design and build woodsolutions.com.au

Hardwood appearance grades (AS2796):

- select
- medium feature
- high feature

High Feature:
Distinct with a rich, lively & vibrant surface.

Medium Feature Standard:
Increased feature providing a surface with distinct natural appeal

Low Feature Select:
Straight & even grain with uniform texture

Specification

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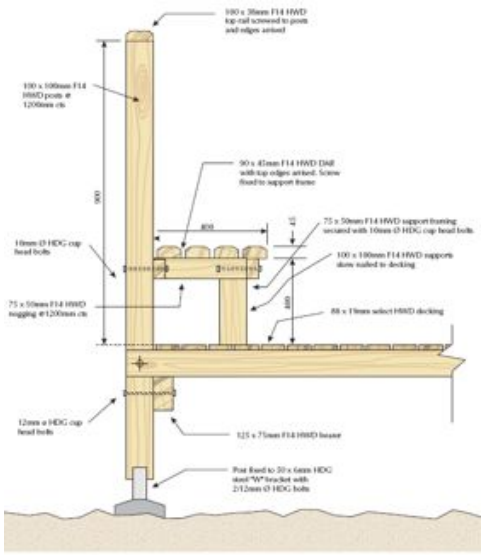
Characteristic	Example of Key Words
Application or Product	Cladding, flooring, rafter, beam, joist, hand rail, etc
Size	Depth (mm) x Breath (mm) x Length (mm or m)
Species or Species group	Mixed hardwood, blackbutt, spotted gum, New England group
Surface Finish	Sawn, dressed, sized, gauged, D.A.R., reeded finish, etc.
Profile	Tongue and Groove (T&G), End matched
Moisture Content	Seasoned or unseasoned
Treatment	Treated H1, H2, H3, H4, H5, H6 or untreated
Durability Class	In-ground / Above Ground Durability Class 1, 2, 3 or 4
Structural Grade	F5, F7, F8, F14, F17, F22, F27, F32
Appearance Grade	Hardwood: Select, Medium feature, High feature Cypress: Grade 1 or 2 Pine: Clear, Appearance, Utility
Special Features	e.g. density between 600 and 700 kg/m³
Fixings	Fixed with 2/75 x 3.15mm diameter galvanised nails
Fabrication details	To specific requirements
Finishing details	One flood coat of water repellent preservative

Wood Basics: Specification



Specification

Specifying wood products

- **Application** – framing, flooring, pergola, kitchen, fascia, cladding, formwork?
- **Performance** – appearance, structural performance, service life, cost?
- **Environment** – inside/outside, exposure to decay and/or termites, exposure to weathering, marine, poolside?

More Information

Wood Solutions
design and build
www.woodsolutions.com.au

Questions?

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