## DURABILITY

### - Making it Happen -

Colin MacKenzie Timber Queensland



TIMBER QUEENSLAND

### Get it right



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### Get it wrong





## No Excuses!



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## Content

- Regulations and Standards
- Design Process
- Some Basics
- Treatment Levels
- H2 vs H2F vs H3
- Specifications
- Where to next



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## **Regulations & Standards**



Review and approve pesticides (preservatives) in accordance with registration label

### AS 1604 etc



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## **Design Process**





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## **Design Process: 1**



# Design Process: 2





# **Design Process: Discussion**

- To determine performance requirements you may need to consider:
  - Target life expectancy (minimum regulatory, standards or contractual requirements)
  - Level of reliability (life safety, cost or consequence of failure)
  - Costs (initial vs ongoing maintenance, repair or replacement)
- In the context of building regulations, the Building Code of Australia (BCA) has implicit durability performance expectations:
  - see Durability in Buildings Guideline Document at www.abcb.gov.au



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## **BCA Design Life Guideline**

#### Table 2.1: BCA Durability Design Life Guideline.

Design life of (yea	building ( <i>dl</i> ) ars)	Design life of components or sub-systems (years)				
			Category			
Category	No. of years	Readily accessi- ble and economi- cal to replace/ repair	Moderate ease of access but difficult or costly to replace or repair	Not accessible or not economical to replace or repair		
Short	1< <b>dl</b> <15	5 or <b>dI</b> (if <b>dI</b> <5)	dl	dl		
Normal	50	5	15	50		
Long	100 or more	10	25	100		

Note: Houses are considered normal, with respective design life requirements of 5, 15 and 50 years.



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## **Timber Hazards**





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## **Timber Hazards**

# From a durability perspective, the main hazards that need to be considered are:-

- In-ground and above ground decay (including hazard or 'H' levels etc)
- Insects (inc. termites) +
- Corrosion (of fasteners)
- Weathering
- Marine borers<sup>4</sup>
- Chemical degradation (not usually an issue), and
- Fire (subject of other resources)

Hazard Classes ('H') apply to these 3 agents

Above ground durability trials, Beerburrum OLD



### Decay

# The performance of timber with respect to decay is:

- Highly related to the presence of free moisture in the wood above 20% moisture content (MC)
- Different with respect to decay when in-ground vs above ground (different timber durability ratings apply in each case)

Macro climatic decay hazard maps have been developed to address these fundamental differences



In-ground durability trials 'Wedding Bells', Nth NSW



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### Decay: In-Ground Decay Hazard Zones



In-ground decay hazard zones for Australia (Zone D has the greatest in-ground decay potential)



### Decay: Above Ground Decay Hazard Zones



Above ground decay hazard zones for Australia (Zone D has the greatest decay hazard potential)



## CTIQ





Figure 1 Above-ground decay hazard zones for Queensland Map compiled by Spatial Support, Information & Technology Services, DEEDI (after MacKenzie et al. 2005)



# Decay: Causes

### To thrive fungi need:

- Moisture > 20% MC in wood
- Oxygen
- Temperature >25° to <40° (ideal)
- Food

Remove <u>any</u> of these four key elements and fungal growth is either stopped or retarded

e.g. preservative treatment renders the 'food' (wood) immune





### **Decay: Absence of Causes Example**

# Wood in an anaerobic condition (i.e. without access to oxygen) lasts indefinitely

e. g. Kauri dug out from the ground after 10,000 to 50,000 years





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### Hazard Classes (H1 – H6 AS 1604)

- H1 fully protected indoors, borers only
- H2 fully protected indoors, borers and termites
- H3 exposed to weather, above ground, well ventilated
- H4 in ground (landscaping)
- H5 in ground (more critical)
- H6 marine piles





## **Decay: Resistance to Decay**

- Natural Durability Ratings apply to heartwood (or true wood) only not sapwood
- Only sapwood can be effectively treated
- Limit non-durable timber to 20% cross-section (max)





## **Examples of In-ground Durability**

### Class 1 (highly durable)

- ironbark, tallowwood, Gympie messmate

### Class 2 (durable)

- spotted gum, blackbutt

### Class 3 (moderately durable)

- brush box, rose gum

### Class 4 (non durable)

 all sapwood for all species, Victorian ash, Tasmania oak, Oregon, radiata pine, slash pine, hoop pine



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## **Examples of Above Ground Durability**

### Class 1 (highly durable)

 ironbark, tallowwood, river red gum, spotted gum, blackbutt, cypress

### Class 2 (durable)

rose gum, jarrah, yellow stringybark, Sydney blue gum , brush box

### Class 3 (moderately durable)

- Victorian ash, Tasmanian oak, huon pine

### Class 4 (non durable)

 all sapwood for all species, Oregon, radiata pine, slash pine, hoop pine For an extensive list of natural durability ratings refer to AS 5604 Timber – Natural durability ratings or the Timber Service Life Design Guide, at www.woodsolutions. com.au



### **Service Life of Heartwood**

Natural Durability	Heartwood Service Life (years) <sup>(1)(2)</sup>							
Class	H1 Fully Protected	H3 Above Ground exposed	H5 In- Ground					
Class 1	50 <sup>+</sup>	>40	25 <sup>+</sup>					
Class 2	50 <sup>+</sup>	15 – 40	15 - 25					
Class 3	50 <sup>+</sup>	7 – 15	5 - 15					
Class 4	50 <sup>+</sup>	0 - 7	< 5					

(1) Based on in-ground graveyard stake trials and above ground 'L' joint trials

(2) Greater service life can be achieved with larger sections, relevant maintenance and/or preservative treatment





### S•ui•t•abl•e••Prt•

ТҮРЕ		HAZARD LEVEL								
		H1	H2	H3	H4	H5	H6			
Water	Boron	:	:							
	ССА	:		:	•	:	. (1)			
	Copper Azole	:	:	:	-	:				
	ACQ	:	:	:	•	:				
Solvent	LOSP	:		:						
Double	CCA + Creosote						:			

(1) Southern waters only

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### **Insects: Termite Hazard Zones**



Termite hazard zones for Australia (Zone D has the greatest termite hazard)



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### **Termite Protection**

- The Building Code (BCA) requires termite protection for buildings in designated termite prone areas
- In termite prone areas, the BCA provides two options:
  - Either all 'primary structural elements' (specific QLD variation requirements) are to be termite resistant (for timber refer to AS 3660.1), OR
  - Termite protection shall be provided in accordance with AS 3660.1 which provides options and combinations including isolation, termite shields, physical and chemical soil barriers, termite resistant materials etc.



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# Whole of House

- Chemical and or Physical Barriers to isolate wood & 'cellulose' from termites
- Regular Inspection
- AS 3660.1 Protection of New Buildings from Subterranean Termites
- TQ Tech Data Sheet 12



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### Technical Data Sheet Protecting Buildings from Subterranean Termites

#### Recommended Practice / March 2006

#### Issued by: Timber Queensland Limited

#### Introduction

All buildings, building materials and building contents are subjected to a number of hazards throughout their useful life. These include physical barriers into the design, coupled with regular inspection of these barriers. Queensland's rich heritage of timber buildings is testimony to the effectiveness of these measures.







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## **Termite Treated Timber**

- Commercial/trade names
- 'T2 Blue', 'T2 Red', 'Red Alert', 'H2 Termigaurd', 'True Blue T2', Terminator, etc
- AS 1604.1 specifies regulatory brands
- H2 = termites and borers all Qld not decay
- H2 'F'= termites and borers Sth of TC
- 'H3' = termites, borers & decay
- 'H4' = in-ground landscaping not structural
- 'H5' = structural in-ground poles, retaining walls



## Brands



## Brands

(2 or 5 mm envelope, 45 mm max thick.)

( all sapwood plus 5 or 8 mm envelope No size limit ) Timber recycles carbon





Max thickness 45 mm

Heartwood of local slash and Carribean pines are termite resistant AS 5604/AS 3660

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## ETP's

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## **Corrosion: Fasteners**

There are two types of corrosion:

#### Embedded

Typical installation of fasteners embedded in wood subjected to corrosion



Note: red marks denote where corrosion is possible

#### Atmospheric

Typical fastener installation subjected to atmospheric corrosion





# **Corrosion: Fasteners**

Most metal fasteners for timber have a part that is in the timber and a part exposed to the atmosphere

### **Embedded portion**

Corrosion of the embedded part will be dictated by:

- the moisture content of the timber
- the natural pH of the timber
- electrolytic action that may occur due to the presence of preservatives such as copper in CCA or ACQ treated timber

The sapwood in this pole has been treated with CCA and is causing accelerated corrosion of the galvanized plate





## **Corrosion: Fasteners**

### **Exposed portion**

Corrosion of the exposed portion of the fasteners will be influenced by:

- all of the embedded factors
- air-borne contaminants such as salt or other chemicals

Macro climatic hazard influences on corrosion need to differentiate between embedded and atmospheric corrosion, and apply separate hazard maps



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### Hazard Zones – Embedded Corrosion



Hazard zones for embedded corrosion (Zone C is the most hazardous)



### Hazard Zones – Exposed Corrosion



Hazard zones for exposed corrosion (Zone E is the most hazardous)



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### Resistance

Resistance to corrosion is best provided by selecting and using material with the required resistance to corrosion, appropriate to the intended life of the structure



Cross-arm King bolt (hot dipped galvanized) after 35 years exposure in power pole.



# Weathering

Unprotected timber exposed to moisture and sunlight will undergo physical and chemical changes known as weathering

Weathering is the result of:

- surface erosion (this is slow 6 mm to 13 mm per century)
- wetting/drying (causing swelling and shrinking)
- chemical change (caused by sunlight and oxygen)
- freezing and thawing in alpine areas



20 year old deck and retaining wall



### Weathering

Note the

degree of

roof.

delineation in

weathering owing to shelter provided

provided by the

Although hazard maps for weathering have not yet been developed, it is generally accepted that the effects of weathering are more severe and accelerated in harsher climates with greater extremes in temperature and rainfall



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## Weathering: Resistance

Protection from weathering can be maximised by:

- Applying appropriate finishes, including paints, stains and water repellants
- Regular maintenance with appropriate finishes
- Architectural and design detailing that specifies overhangs, capping, verandahs and shading
- Considering ventilation, water shedding and drainage during design and construction



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### **Good Detailing**





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## Good Detailing



A well-ventilated, free-draining post support.



Capping protects top and end grain of projected beam.



Good detailing (staggered screws and DPC over joists) used for this prefabricated bridge.



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### **Marine Borers**

Where timber (piles, braces etc.) is in contact with marine waters (ocean, bay and tidal), specific hazards such as marine borers and organisms need to be considered.

Factors that affect the level of marine borer hazard include:

- Macro-climatic hazard zone (warmer waters, higher hazard)

- Water salinity
- Sheltering effects
- Construction details

Aquaculture is a valuable wood use.

### **Marine Borers**

Marine piles and timber in marine contact are best protected by:

- Using species with high natural resistance such as turpentine or in cooler southern waters, swamp box, river red gum or white mahogany
- Using preservative treated timbers ('H6') with wide sapwood bands such as spotted gum and plantation softwoods
- Using mechanical barriers and floating collars

Piles encased in sand filled concrete pipe





### **Marine Borers: Hazard Zones**



Marine borer hazard zones (Zone G is the most hazardous)



### **Marine Borers: Resistance**

AS 5604 provides an extensive list of species with their marine borer resistances where known – as seen in the extract below.

NATURAI	L DURABILI	TY RATINGS OF T	IMBER S	PECIES		
1	2	3		5		
Standard common name	Lyctid	Termite resistance of heartwood (inside	Natural di of he	Marine-		
and scientific/botanical name	susceptibility of sapwood	above ground— applicable to H2 in AS 1604 series)	In-ground contact, D <sub>ig</sub>	Outside above ground, D <sub>ag</sub>	resistance of heartwood	
gum, blue, southern Eucalyptus globulus	S	NR	3	2	4	
gum, blue, Sydney Eucalyptus saligna	S	NR	3	2	3	
gum, grey Eucalyptus canaliculata Eucalyptus major Eucalyptus propinqua Eucalyptus punctata	NS	R	1	1	2	
gum, grey, mountain Eucalyptus cypellocarpa	S	NR	3	2	4	

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### Fire

- Fire is covered by additional TQ/WS resources:
  - Using Wood in Bushfire-prone Areas
  - Fire Safety and Performance of Wood in Multi-Residential and Commercial Buildings



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### Maintenance

The satisfactory performance of timber structures will often depend on adequate maintenance programs.

Maintenance issues to consider are:

- Finishes
- Termite barriers, inspection and replenishment of treatments
- Maintaining sub-floor ventilation
- Tightening bolts and fasteners
- Re-applying supplementary preservatives and sealants
- Cleaning sweep or blow, don't hose away (moisture issues)



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### **CTIQ - 2 Books**



Construction timbers in Queensland Book 1: Definitions and descriptions

Toward C

Queensland Government



Construction timbers in Queensland Book 2: Properties and specifications

Toward

Tomorrow's Queensland: strong, green, smart, healthy and fair



Queensland Government

Tomorrow's Queensland: strong, green, smart, healthy and fair



## CTIQ – Book 1 - Contents

Information relating to applications, target design life and decay hazard zones contained in Book 2

Target design life

Applications

Above-ground decay hazard zones

In-ground decay hazard zones

Conditional use codes in Schedules A, B and C

Advisory codes used in Part 2 of Schedules

Seasoning and timber moisture content

Building members, target design life and applications

5 target design life applications

15 year target design life applications

50 target design life applications Schedules A, B and C



### **Book 1** – Durability Performance

Note 9: Regulatory durability

performance requirements

The ABCB has published a guideline "Durability in Buildings". It explains the implicit requirements of the BCA that should be followed by manufacturers and specifiers wishing to satisfy the BCA's requirements.

CTIQ reflects the performance expectations implicit in the BCA as at 2006.





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## Book 1 – Target Design Life

Building member	Environment	Target design life (yrs)	Application (Column no. in Schedules A, B and C)
architraves	protected	15	12
balustors	exposed	50	16
Dalusiers	protected	50	15
barge boards	exposed	15	13
	between stumps	5	11
	under lining or cladding	50	15
battana	external wall	15	13
Dattens	greenhouse	15	13
	pergola	15	13
	roof, ceiling	50	15
boomo	exposed	50	16
Deams	protected	50	15
boarors	exposed	50	16
Dealers	protected	50	15



### CTIQ – Book 1 – Hazard Zones





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## CTIQ - Layout – Book 2

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tructural	3		F27	F22	F17	F14	F11	F8	F7	F5	F4		105		data available	ê		
tructural	4		F22	F17	F14	F11	F8	F7	F5	F4	-							
tructural	5	_	-	-	-	-	E7	FS	F4	-	-							

Fold-out guides for PART 2 of the Schedules									
Blue highlight indicates hardwood	Yellow highlight in	dicates softwood							
<ul> <li>Approved Subject to conditions of use and treatment requirements speci</li> </ul>	x Not approved								

Columns 12 to 17—Conditions of use codes								
Code	Condition	Code	Condition					
C1	Desapped for in-ground contact if untreated	C11	Pole frame construction poles must be set in stimups					
C2	Minimum dimension – 100 x 100 mm	C12	Single species only, free of heart					
C3	Minimum dimension – 150 x 150 mm	C13	Desapped where in-ground-min diameter 200 mm					
C4	Minimum dimension – 200 x 200 mm	C14	Desapped where in-ground-min diameter 300 mm					
cs	Round timber only- treatment H4 min	C15	Desapped where in-ground-min diameter 400 mm					
C6	Round timber > 200 mm diameter = H4 min	C16	Seasoned					
C7	Round timber > 200 mm diameter - HS min	C17	weather exposed door jambs & mullions must comply with industry					
C8	Round timber > 300 mm diameter = H5 min		recommendations					
C9	Round timber > 400 mm diameter = HS min	H3	Minimum H3 level of preservative treatment					
C10	Part seasoned – max MC 20%	H4	Minimum H4 level of preservative treatment					
		HS	Minimum HS level of preservative treatment					
	Columns 13 to	17-De	cay hazard zones					
Abo	ve-ground decay hazard zones	1	In-ground decay hazard zones					
Ag:A	Least potential for above- ground decay	Ig:A	Least potential for in-ground decay					
Ag:B	Lower than Aq:C – greater than Ag:A	Ig:8	Lower than Ig:C - greater than Ig:A					
Ag:C	Lower than Ag:D – greater than Ag:B	Ig:C	Lower than Ig:D – greater than Ig:B					
Ag:D	greatest potential for above- ground decay	Ig:D	greatest potential for in-ground decay					

Structural 4 Structural 5

	Column 18-	Advisory	Codes
Advisory	codes provide general information	relevant to,	particular species
Code	Condition	Code	Condition
A1	High shrinkage	A5	Included bark sometimes present
A2	Density, hardness & strength vary with origin and species	A7	Finishes sometimes affected by resin bleed
A3	Gum veins common	A8	Latex canals common
A4	Paint / protect against Queensland pine beetle	A9	Corrodes ferrous fastenings when wet
AS	Usually knotty		

	Columns 11 to 17—Applications								
Column									
11	5 year target design life applications								
12	15 year target design life applications: protected, non-structural building applications								
13	15 year target design life applications: weather-exposed, structural and/or non-structural building applications								
14	15 year target design life applications: in-ground, accessible, structural building applications								
15	50 year target design life applications: protected, structural and/or non- structural building applications								
16	50 year target design life applications: weather-exposed, structural and/or non-structural building applications								
17	S0 year target design life applications: in-ground, structural building applications								



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# Government Work

- If you are tendering/bidding on Government (QBuild/Project Services etc) work pay particular attention to the specifications relating to preservative treatment
- In some instances, even for fully enclosed framing, they may require a H3 treatment level



# Where to next?

- All relevant timber standards relating to durability must become performance based and reflect community and regulatory expectations
- To achieve this, they need to address service/design life performance and
- Be based on the science of reliability



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# What is Industry Doing?

- Change the 'culture' at corporate Industry and Standards Australia committee levels
- Push for transfer and adoption of science and technology from the R&D to Australian Standards and Regulations
- Needs whole of building/timber industry support to realize.



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### Conclusion

- Timber has the ability to deliver design service life in a wide range of applications
- There are significant issues that need to be considered to appropriately design, specify and detail timber structures to ensure satisfactory durability performance
- These issues are well known, understood and documented for building industry use



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### **More Information**



Timber service life design Design guide for durability

### **Technical Design Guide Timber Service Life Design**





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