DURABILITY
- Making it Happen -

Colin MacKenzie
Timber Queensland
Get it right

Get it wrong

Timber recycles carbon
Content

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

APVMA

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

AS 1604 etc
Regulations & Standards

BCA

AS 1684
AS 1720

QLD - CTIQ

AS 1604

AS 3660.1
Design Process
Design Process: 1

1. Determine Application
   - Estimate required performance by considering
     - Required reliability
     - Required life
     - Initial vs ongoing cost

2. Determine what hazards, if any, are present
   - Decay, termites, corrosion etc.

3. Develop specifications to satisfy the above by considering factors affecting durability as follows
   - Members/cladding etc.
   - Joints
Design Process: 2

**MEMBERS/CLADDING ETC.**

1. **DETERMINE REQUIRED NATURAL DURABILITY CLASS AND/OR**
2. **COMBINATION OF REQUIRED NATURAL DURABILITY AND PRESERVATIVE TREATMENT LEVEL ("H" LEVEL)**
3. **ESTABLISH ENHANCEMENTS (IF NECESSARY)**
4. **PROTECT FROM INSECTS OR MARINE BORERS IF REQUIRED**
5. **ARCHITECTURAL DETAILING**
6. **MEMBER TYPE AND GLUE SPECIFICATION**
7. **GRADE SIZE AND MOISTURE CONTENT**
8. **FINISHING AND MAINTENANCE**

**JOINTS**

1. **DETERMINE REQUIRED NATURAL DURABILITY CLASS AND/OR**
2. **COMBINATION OF REQUIRED NATURAL DURABILITY AND PRESERVATIVE TREATMENT LEVEL**
3. **ESTABLISH ENHANCEMENTS (IF NECESSARY)**
4. **CORROSION RESISTANCE (CHECK COMPATIBILITY WITH PRESERVATIVE)**
5. **MOISTURE CONTENT**
6. **JOINT DETAILING**
7. **FINISHING AND MAINTENANCE**
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:
### BCA Design Life Guideline

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

<table>
<thead>
<tr>
<th>Design life of building ($dl$) (years)</th>
<th>Design life of components or sub-systems (years)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Readily accessible and economical to replace/repair</td>
<td>Moderate ease of access but difficult or costly to replace or repair</td>
</tr>
<tr>
<td>Category</td>
<td>No. of years</td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td>$1 &lt; dl &lt; 15$</td>
<td>$dl$</td>
</tr>
<tr>
<td>Normal</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>Long</td>
<td>100 or more</td>
<td>10</td>
</tr>
</tbody>
</table>

**Note:** Houses are considered normal, with respective design life requirements of 5, 15 and 50 years.
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
- 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 QLD
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.
Decay: In-Ground Decay Hazard Zones

In-ground decay hazard zones for Australia (Zone D has the greatest in-ground decay potential)
Above ground decay hazard zones for Australia
(Zone D has the greatest decay hazard potential)
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 any of these four key elements and fungal growth is either stopped or retarded

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

<table>
<thead>
<tr>
<th>Natural Durability Class</th>
<th>Heartwood Service Life (years) $^{(1)}$ $^{(2)}$</th>
<th>H1 Fully Protected</th>
<th>H3 Above Ground exposed</th>
<th>H5 In- Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td></td>
<td>50$^+$</td>
<td>&gt;40</td>
<td>25$^+$</td>
</tr>
<tr>
<td>Class 2</td>
<td></td>
<td>50$^+$</td>
<td>15 – 40</td>
<td>15 - 25</td>
</tr>
<tr>
<td>Class 3</td>
<td></td>
<td>50$^+$</td>
<td>7 – 15</td>
<td>5 - 15</td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td>50$^+$</td>
<td>0 - 7</td>
<td>&lt; 5</td>
</tr>
</tbody>
</table>

$^{(1)}$ 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
### Suitable Preservatives

<table>
<thead>
<tr>
<th>TYPE</th>
<th>HAZARD LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H1</td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td></td>
</tr>
<tr>
<td>CCA</td>
<td></td>
</tr>
<tr>
<td>Copper Azole</td>
<td></td>
</tr>
<tr>
<td>ACQ</td>
<td></td>
</tr>
<tr>
<td>Solvent</td>
<td></td>
</tr>
<tr>
<td>LOSP</td>
<td></td>
</tr>
<tr>
<td>Double</td>
<td></td>
</tr>
<tr>
<td>CCA + Creosote</td>
<td></td>
</tr>
</tbody>
</table>

(1) Southern waters only

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Insects: Termite Hazard Zones

Termite hazard zones for Australia
(Zone D has the greatest termite hazard)
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.
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
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 exposure to water, vermin and pests, fire and water damage. 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
- 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

1234 75 H2 ‘F’ ‘Not to be used North of tropic of Capricorn’

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

1234 73 H2

(all sapwood plus 5 or 8 mm envelope
No size limit)
Envelope H2 ‘F’

Max thickness 45 mm

H2

All sapwood treated + limitations on untreated heartwood in some cases

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

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ETP’s
There are two types of corrosion:

**Embedded**
Typical installation of fasteners embedded in wood subjected to corrosion

**Atmospheric**
Typical fastener installation subjected to atmospheric corrosion

*Note: red marks denote where corrosion is possible*
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
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
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)
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
Weathering

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.

Note the delineation in degree of weathering owing to shelter provided by the roof.
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
Good Detailing

Provide 75mm air gap or DPC on metal shield/bearing plate to end grain.

Minimise horizontal and vertical contact areas (avoid housed joints) and ensure good ventilation to end grain.

Provide capping or sloping cuts to posts.

Provide free drainage or drainage holes to all potential moisture traps such as in the bottom rail of lattice panels.

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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.
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
Marine Borers: Hazard Zones

Marine borer hazard zones (Zone G is the most hazardous)
AS 5604 provides an extensive list of species with their marine borer resistances where known – as seen in the extract below.

## Marine Borers: Resistance

<table>
<thead>
<tr>
<th>Standard common name and scientific/botanical name</th>
<th>Lyctid susceptibility of sapwood</th>
<th>Termite resistance of heartwood (inside above ground—applicable to H2 in AS 1604 series)</th>
<th>Natural durability class of heartwood</th>
<th>Marine-borer resistance of heartwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>gum, blue, southern <em>Eucalyptus globulus</em></td>
<td>S</td>
<td>NR</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>gum, blue, Sydney <em>Eucalyptus saligna</em></td>
<td>S</td>
<td>NR</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>gum, grey <em>Eucalyptus canaliculata</em></td>
<td>NS</td>
<td>R</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><em>Eucalyptus major</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Eucalyptus propinqua</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Eucalyptus punctata</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gum, grey, mountain <em>Eucalyptus cypellocarpa</em></td>
<td>S</td>
<td>NR</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
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
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)
Construction timbers in Queensland
Book 1: Definitions and descriptions

Construction timbers in Queensland
Book 2: Properties and specifications

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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

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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.
## Book 1 - Target Design Life

<table>
<thead>
<tr>
<th>Building member</th>
<th>Environment</th>
<th>Target design life (yrs)</th>
<th>Application (Column no. in Schedules A, B and C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>architraves</td>
<td>protected</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>balusters</td>
<td>exposed</td>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>protected</td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td>barge boards</td>
<td>exposed</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>between stumps</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>battens</td>
<td>under lining or cladding</td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>external wall</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>greenhouse</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>pergola</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>roof, ceiling</td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td>beams</td>
<td>exposed</td>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>protected</td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td>bearers</td>
<td>exposed</td>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>protected</td>
<td>50</td>
<td>15</td>
</tr>
</tbody>
</table>
CTIQ - Book 1 - Hazard Zones

Above Ground

In-Ground
### Properties

<table>
<thead>
<tr>
<th>Species</th>
<th>Grain Pattern</th>
<th>Heartwood Colour</th>
<th>Ring porous</th>
<th>Tracheid Type</th>
<th>Ultimate Strength</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

### Application

<table>
<thead>
<tr>
<th>Application</th>
<th>Maximum Use</th>
<th>Example Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

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**Timber recycles carbon**

**CTIQ - Layout - Book 2**
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.
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.
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
More Information

Technical Design Guide
Timber Service Life Design

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