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Timber Durability
TECHNICAL REPORT

TIMBER DURABILITY CLASSIFICATION

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Contents

Executive Summary

- This document presents the classification of timber against decay inground, decay aboveground, corrosion of embedded fasteners and marine borer attack. As the results, the durability classes of hundreds of timber species commonly used for timber construction in Australia are established.

1. Timber Classification for In-ground & Aboveground Decay

There are 2 sources of timber species commonly used in Australia:

- Thornton's table (currently implemented in the Timber Durability Database) (Thornton *et al.*, 1997)
- TRADAC table (TRADAC, 1999)

Combination of these tables and filling in all available information about the species result in the table 'Species Available' in Table 1.1. The column 'key' in this table indicates the source of the species:

- Key = 1: the species appears in both tables
- Key = 2: the species appears in TRADAC table only
- Key = 3: the species appears in Thornton's table only

Column 'species type' shows type of timber, including Eucalyptus (E), Non-Euc. Hardwood (H) and Softwood (S). The table is sorted according to the species type and then to the density in ascending order. Following 4 plots are then made for each species type:

- In-ground decay rating vs. density
- Above-ground decay rating vs. density

Figure 1.1 shows the plots for Eucalyptus species, Figure 1.2 is for Non-Euc. Hardwood species, and Figure 1.3 is for softwood species. These data are from 'tested species'.

To determine the ratings of untested species, following rules are made:

- ***For Eucalyptus***
    - *For In-ground decay rating*: Use 'average density' line as shown in Figure 1.4. The average density of one class is the average density of all tested species in the class. The class range limits are then estimated by 'half-dividing rule' as in Fig. 1.4. An untested species is classified as
        - Class 1 when its density > 998 kg/m^3
        - Class 2 when 904 < density < 998
        - Class 3 when 823 < density < 904
        - Class 4 when density < 823

- *For Above-ground decay rating*: 80% of the available tested results shows that above-ground decay rating is one class lower (better) than the in-ground decay class, as shown in Figure 1.5, then
    - For untested species, use one class better than the In-ground decay class
    - For tested species, leave the rating as it is

- ***For Non-Euc. Hardwood***
    - *For In-ground decay rating*: Use 'average density' line as shown in Figure 8. The average density of one class is the average density of the tested species in the class (with some exclusion of a few 'rogue' data points, which are marked 'x' in Figure 2). The class range limits are then estimated by 'half-dividing rule' as in Fig. 1.6. An untested species is classified as
        - Class 1 when its density > 980 kg/m^3
        - Class 2 when 865 < density < 980
        - Class 3 when 764 < density < 865
        - Class 4 when density < 764
    - *For Above-ground decay rating*:
        - For untested species, use one class better than the In-ground decay class
        - For tested species, leave the rating as it is

- ***For Softwood***
    - *For In-ground decay rating*:
        - For untested species, use class 4
        - For tested species, leave the rating as it is
    - *For Above-ground decay rating*:
        - For untested species, use the same class as in-ground rating if the in-ground class is a tested value; otherwise use class 4
        - For tested species, leave the rating as it is

The complete table of timber classification for in-ground and aboveground decay is the table 'Species Available' in Table 1.1. The table is sorted according to the trade name of the

species. Some additional information and/or modification were made during the development course and marked in the table as follows,

(*) Aboveground decay class from Myron's test

(") Inground decay class provided by Gary for the Durability Database

(') Inground decay class of NSW timber commercially significant for in-ground use (BCE Doc 01/248)

(#) Suggestion from Colin MacKenzie (for the 2002 Compendium)

AS1604 decay class is used where Thornton's class is different from TRADAC's class

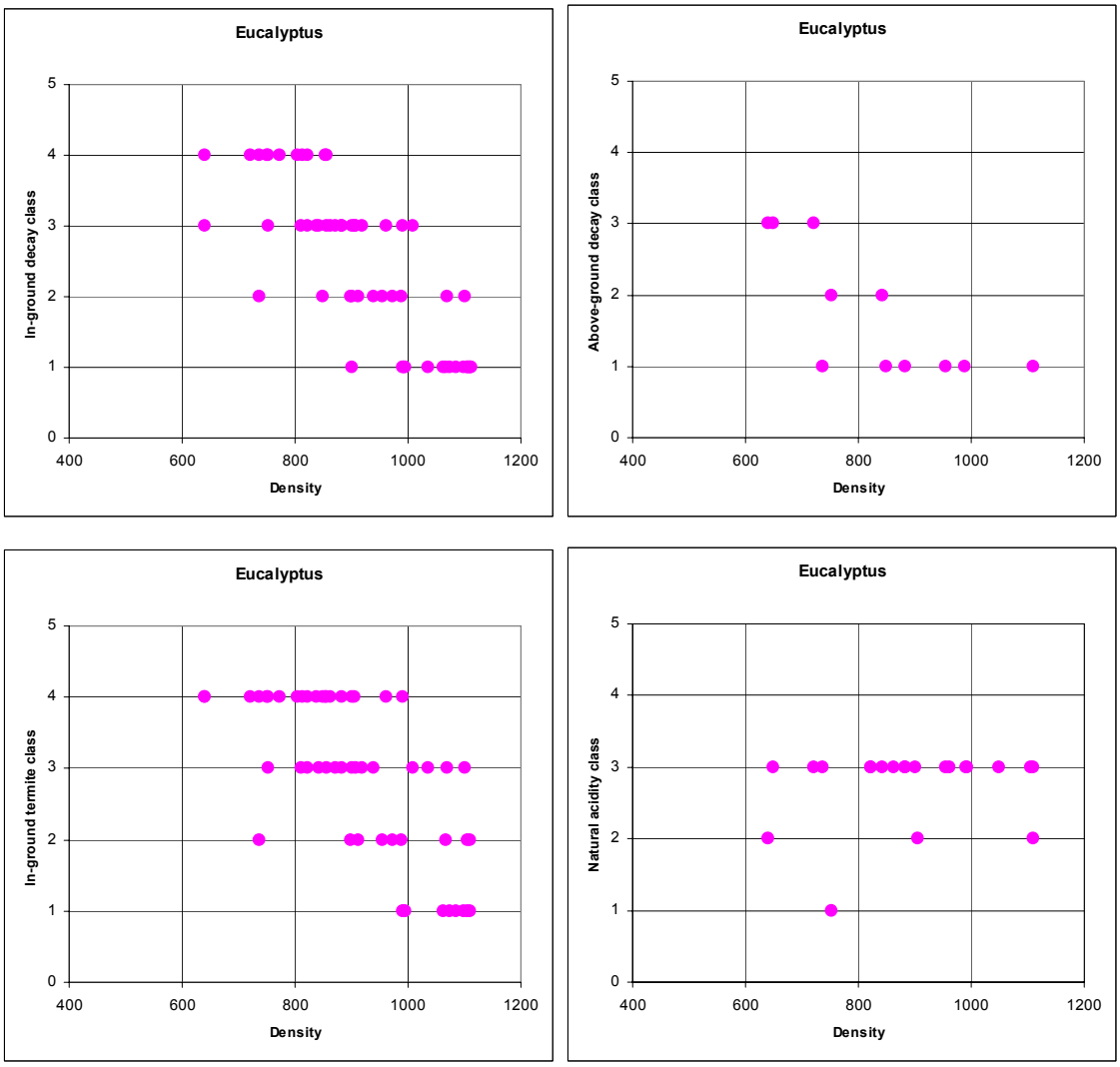

Figure 1.1: Available data of tested Eucalyptus species

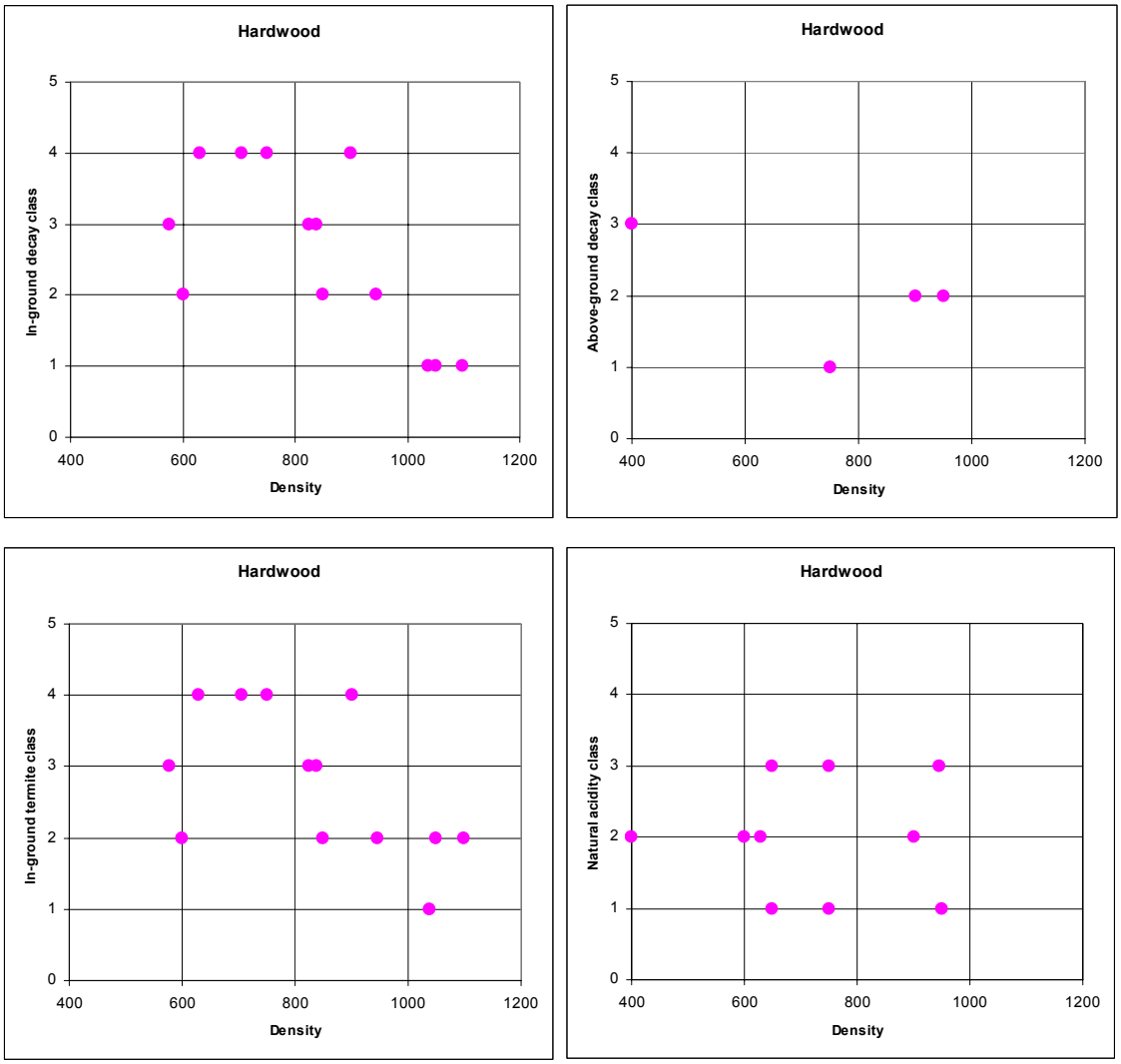

Figure 1.2: Available data of tested Non-Euc. Hardwood species

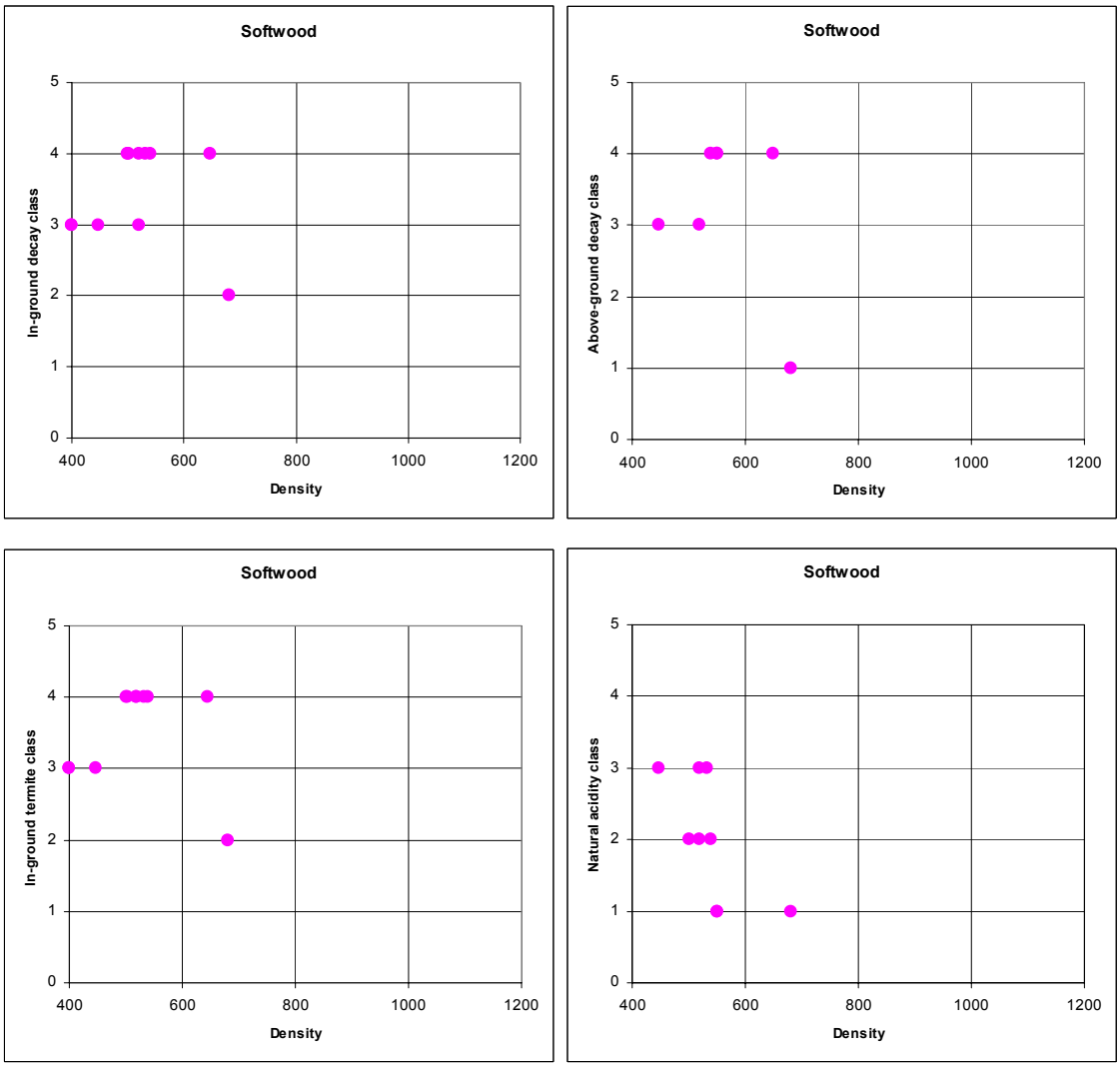

Figure 1.3: Available data of tested Softwood species

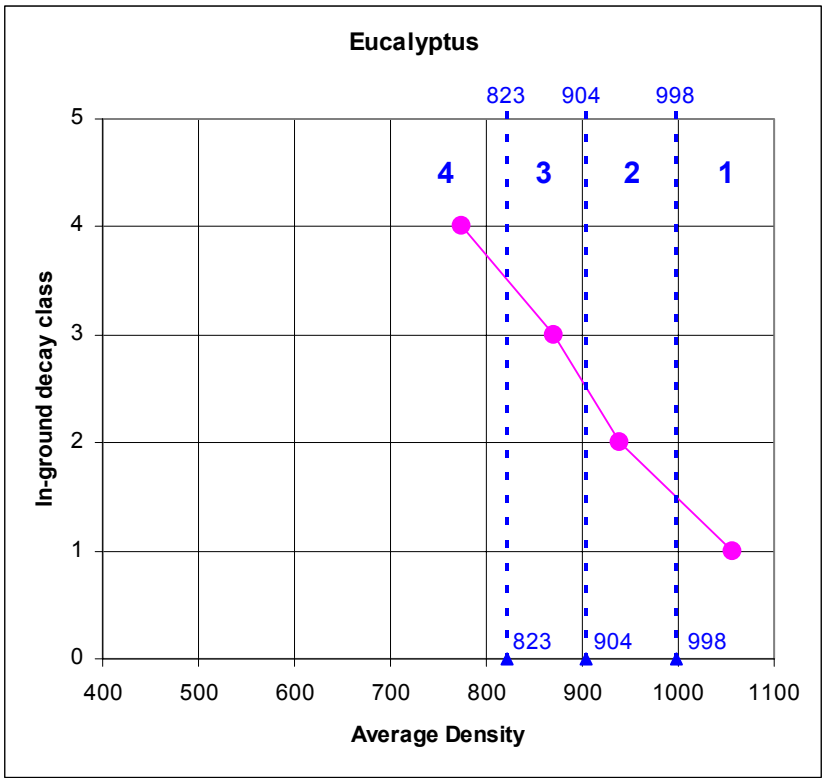

Figure 1.4 Average Density line and rating ranges for Eucalyptus

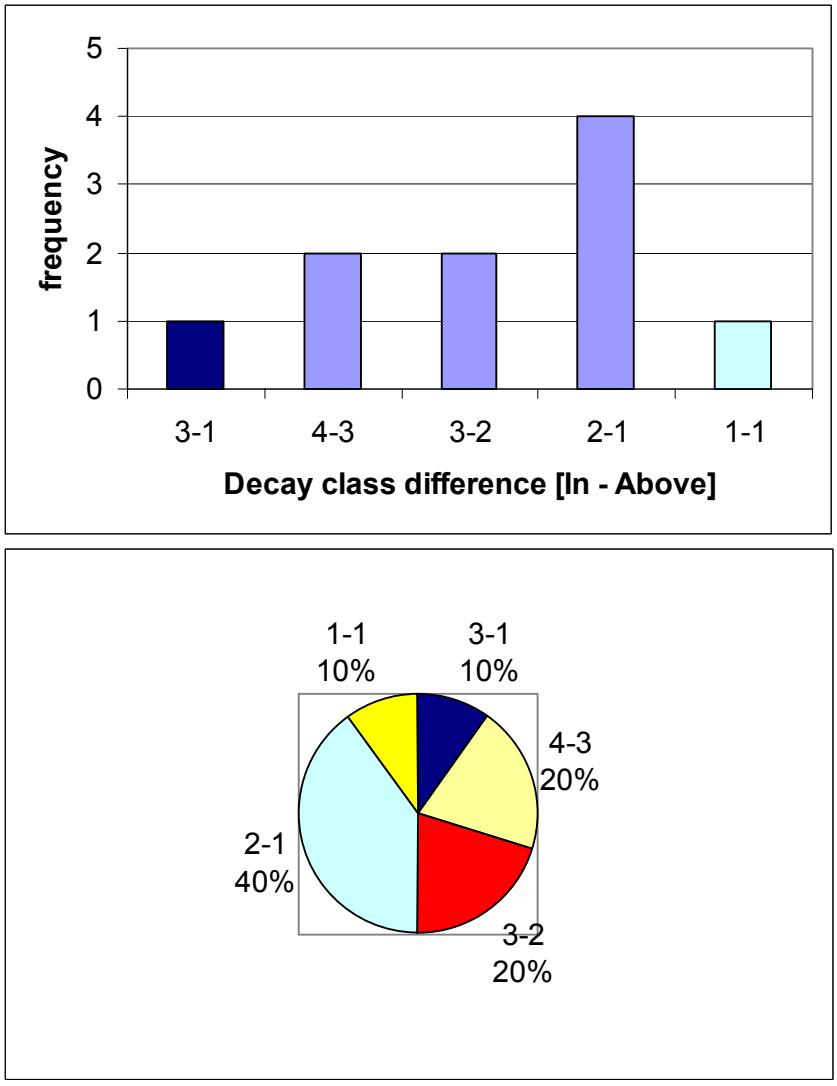

Figure 1.5 Correlation between In-ground and above-ground decay class for Eucalyptus

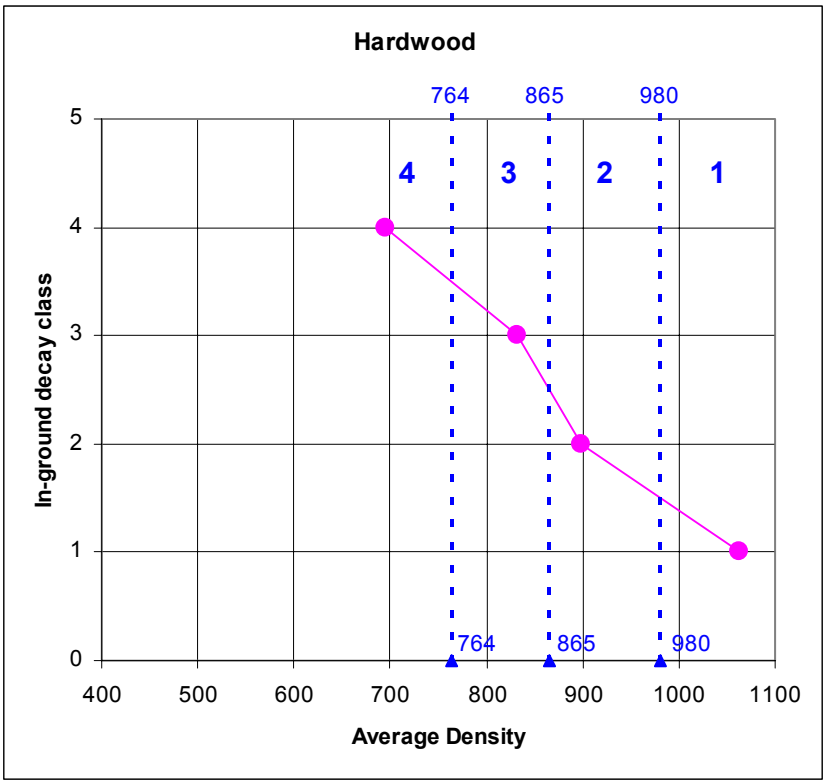

Figure 1.6 Average Density line and rating ranges for Non-Euc. Hardwood

Table 1.1 Classification of timber for inground decay and aboveground decay

Key	Thornton ID	Standards Australia index no	**trade name**	**botanical name**	species type	density	In-ground decay class	Above-ground decay class
2	-	22	Ash, alpine	Euc. delegatensis	E	650	4	3*
2	-	25	Ash, crown	Flindersia australis	H	950	1	1
1	55	30	Ash, mountain	Euc. regnans	E	640	4	3*
1	39	37	Ash, silvertop	Euc. sieberi	E	862	3	2
2	-	-	Balau (selangan batu)	Shorea spp.	H	900	2	1
2	-	-	Bangkirai	Shorea laevifolia	H	850	2	1
1	64	65	Beech, myrtle	Nothofagus cunninghamii	H	705	4	3
2	-	-	Belian (ulin)	Eusideroxylon zwageri	H	1000	1	1
1	29	84	Blackbutt	Euc. pilularis	E	884	3	1*
2	-	86	Blackbutt, New England	Euc. andrewsii	E	850	2	1
1	32	87	Blackbutt, WA	Euc. patens	E	849	2	1*
2	-	88	Blackwood	Acacia melanoxylon	H	650	4	3
1	-	97	Bloodwood, red	Corymbia intermedia / Euc.	E	900	1	1
3	-	90	Bloodwood, white	Euc. trachyphloia	E	1023	1"	1
3	62	109	Bollywood	Litsea reticulata	S	532	4	4
1	42	121	Box, brush	Lophostemon confertus	H	900	4	3*#
3	0	126	Box, grey	Euc. moluccana	E	1105	1	1
1	6	127	Box, grey, coast	Euc. bosistoana	E	1110	1	1
3	43	134	Box, long leaved	Euc. goniocalyx	E	873	3	2
3	79	138	Box, red	Euc. polyanthemos	E	1064	1	1
3	-	144	Box, steel	Euc. rummeryi	E	?	1'	1
3	4	145	Box, swamp	Lophostemon suaveolens	H	850	2	1
3	8	150	Box, yellow	Euc. melliodora	E	1075	1	1
3	82	148	Box, white	Euc. albens	E	1112	1	1
3	59	162	Brigalow	Acacia harpophylla	H	1099	1	1
1	52	165	Brownbarrel	Euc. fastigata	E	738	4	3
3	53	167	Bullich	Euc. megacarpa	E	640	3	2
2	-	-	Calantas (kalantas)	Toona calantas	H	500	2	1
1	54	178	Candlebark	Euc. rubida	E	750	4	3
1	70	73	Cedar, red, western	Thuja plicata	S	448	3	2*#
1	73	544	Cypress	Callitris Glaucophylla	S	680	2	1*
1	71	114	Fir, Douglas	Pseudotsuga menziesii	S	520	4	4*

1	40	253	Gum, blue, southern	Euc. globulus	E	900	3	2
1	41	254	Gum, blue, Sydney	Euc. saligna	E	843	3	2*
2	-	266	Gum, grey	Euc. propinqua	E	1050	1	1
1	37	267	Gum, grey, mountain	Euc. cypellocarpa	E	961	3	2
3	36	268	Gum, maiden's	Euc. maidenii	E	992	3	2
1	47	269	Gum, manna	Euc. viminalis	E	814	4	3
2	-	272	Gum, mountain	Euc. dalrympleana	E	700	4	3
1	10	281	Gum, red, forest	Euc. tereticornis	E	737	2	1*
1	13	281	Gum, red, river	Euc. camaldulensis	E	913	2	1
1	50	284	Gum, rose	Euc. grandis	E	753	3	2*
3	16	286	Gum, salmon	Euc. salmonophloia	E	1070	2	1
3	30	288	Gum, scribbly	Euc. haemastoma	E	907	3	2
2	-	289	Gum, shining	Euc. nitens	E	530	4	3
1	31	293	Gum, spotted	Corymbia maculata /Corymbia	E	988	2	1*
3	18	294	Gum, sugar	Euc. cladocalyx	E	1105	1	1
3	9	305	Gum, yellow	Euc. leucoxylon	E	1008	3	2
2	-	310	Hardwood, Johnstone River	Backhousia bancroftii	H	950	3	2*
2	-	-	Hemlock, western	Tsuga heterophylla	S	500	4	4
1	1	322	Ironbark, grey	Euc. paniculata	E	1110	1	1*
1	3	325	Ironbark, red	Euc. sideroxylon	E	1086	1	1
3	-	326	Ironbark, red (broad-leaved)	Euc. fibrosa	E	1116	1'	1
3	-	327	Ironbark, red (narrow-leaved)	Euc. crebra	E	1046	1'	1
2	-	336	Ironwood Cooktown	Erythrophleum chlorostgchys	H	1220	1	1
3	60	340	Jam, raspberry	Acacia acuminata	H	1038	1	1
1	11	341	Jarrah	Euc. marginata	E	823	3	2
2	-	-	Kapur	Dryobalanops spp.	H	750	3	1*
1	46	344	Karri	Euc. diversicolor	E	905	3	2
2	-	-	Keruing	Dipterocarpus spp.	H	750	4	3
1	57	173	Kwila	Intsia bijuga	H	825	3	1#
2	-	-	Mahogany, Philippine, red, dark	Shorea spp.	H	650	3	2
2	-	-	Mahogany, Philippine, red, light	Shorea, Pentacme, Parashorea spp.	H	550	4	3
1	12	384	Mahogany, red	Euc. resinifera	E	955	2	1*
1	21	391	Mahogany, white	Euc. acmenoides	E	993	1	1
3	-	391	Mahogany, white	Euc. umbra	E	887	1"	1
1	17	387	Mahonany, southern	Euc. botryoides	E	919	3	2
3	44	411	Mallet, brown	Euc. astringens	E	974	2	1
1	35	432	Marri	Euc. Calophylla	E	855	4	3

2	-	-	Meranti, red, dark	Shorea spp.	H	650	4	3
2	-	-	Meranti, red, light	Shorea spp.	H	400	4	4*#
3	61	226	Mersawa (Garawa)	Anisoptera thyrifera	H	630	4	3
1	48	434	Messmate	Euc. obliqua	E	722	4	3*
1	7	435	Messmate, Gympie	Euc. cloeziana	E	996	1	1
3	56	458	Oak, bull	Allocasuarina luehmannii	H	1050	1	1
1	66	240	Oak, white, American	Quercus alba	H	750	4	3
3	45	509	Peppermint, black	Euc. amygdalina	E	753	4	3
3	33	510	Peppermint, broad leaved	Euc. dives	E	811	3	2
1	49	512	Peppermint, narrow leaved	Euc. radiata / Euc. Australiana	E	822	4	3
3	51	515	Peppermint, river	Euc. elata	E	804	4	3
3	75	529	Pine, black	Prumnopitys amara	S	500	4	4
2	-	533	Pine, caribbean	Pinus caribaea	S	550	4	4*
1	74	534	Pine, celery-top	Phyllocladus asplenifolius	S	646	4	2#
2	-	545	Pine, hoop	Araucaria cunninghamii	S	550	4	4*
3	77	546	Pine, Huon	Lagarostrobos franklinii	S	520	3	3
3	76	548	Pine, kauri	Agathis robusta	S	503	4	4
3	78	549	Pine, King William	Athrotaxis selaginoides	S	400	3	2#
1	72	559	Pine, radiata	Pinus radiata	S	540	4	4*
2	-	561	Pine, slash	Pinus elliottii	S	650	4	4*
2	-	-	Ramin	Gonystylus spp.	H	650	4	4#
3	69	326	Redwood	Sequoia sempervirens	S	400	2#	2#
3	58	332	Rosewood, New Guinea	Pterocarpus indicus	H	577	3	2
3	26	635	Satinay	Syncarpia hillii	H	838	3	2
2	-	668	Stringybark, Blackdown	Euc. sphaerocarpa	E	1000	2	1
1	34	671	Stringybark, brown	Euc. baxteri	E	838	3	2
3	38	676	Stringybark, red	Euc. macrorhyncha	E	899	2	1
1	20	680	Stringybark, white	Euc. Eugenioides 2	E	856	4	2#
3	22	680	Stringybark, White (Wilkinson's)	Euc. Eugenioides 1	E	856	3	2
1	24	681	Stringybark, yellow	Euc. muelleriana	E	884	3	2
1	5	688	Tallowwood	Euc. microcorys	E	990	1	1
2	-	-	Taun	Pometia pinnata	H	700	3	2
3	65	369	Teak, Burmese	Tectona grandis	H	600	2	1
3	15	713	Tingle, red	Euc. jacksonii	E	772	4	3

3	25	714	Tingle, yellow	Euc. guilfoylei	E	900	2	1
3	28	720	Tuart	Euc. gomphocephala	E	1036	1	1
1	27	723	Turpentine	Syncarpia glomulifera	H	945	1#	1
3	2	747	Wandoo	Euc. wandoo	E	1099	1	1
3	19	774	Woolybutt	Euc. longifolia	E	1068	1	1
3	14	780	Yate	Euc. cornuta	E	1100	2	1
3	23	788	Yertchuk	Euc. consideniana	E	939	2	1

Legends: (*) Aboveground decay class from Myron's test
(") Inground decay class provided by Gary for the Durability Database
(') Inground decay class of NSW timber commercially significant for in-ground use (BCE Doc 01/248)
(#) Suggestion from Colin MacKenzie (for the 2002 Compendium)
AS1604 decay class only given where Thornton's class is different from TRADAC's class

2. Timber Acidity Classification for Embedded Corrosion

In the embedded corrosion model, it is assumed that the corrosion of fasteners embedded in untreated timber is related to the acidity of the timber, defined as (7− pH), where pH is the acidity of free water in contact with the wood. A collection of acidity values derived from BCE measurements and reports by Davis (1994) and Bootle (1983) are listed in Table 2.1.

Table 2.1. Reported pH values of timber species

Common Name	Botanical Name	BCE	Bootle	Davis	Suggested Design pH
Alder, brown	*Caldcluvia paniculosa*		5.0		5.0
Ash, Alpine	*Eucalyptus delegatensis*		3.6		3.6
Ash, Crow's	*Flindersia australis*		5.1		5.1
Ash, English	*Fraxinus excelsoir*		3.5-5.3		4.0
Ash, Silver	*Flindersia bourjotiana*		5.1		5.1
Ash, Silvertop	*Eucalyptus sieberi*		3.5		3.5
Ash, mountain	*Eucalyptus regnans*	4.7			4.7
Balsa	*Ochroma pyramidale*		5.4-7.2		6.0
Baltic, red	*Pinus sylvestris*		4.3-4.6		4.5
Baltic, white			4.0-5.0		4.5
Bangalay				3.56	3.6
Bean, black	*Castanospermum australe*		3.8-5.2		4.2
Beech	*Fagus* spp?			4.5-5.9	5.0
Beech, European	*Fagus sylvatica*		4.5-6.1		5.0
Beech, negrohead	*Nothofagus moorei*		4.6-5.1		5.0
Beech, silky	*Citronella moorie*		5.7		5.7
Beech, white	*Gmelina dairympleana*		4.6-5.0		4.8
Birch, white	*Schizomeria ovata*		3.9-4.9		4.2
Blackbutt	*Eucalyptus pilularis*	4.69	3.4	3.12-3.25	3.6
Bloodwood, red	*Eucalyptus gummifera*		3.6		3.6
Bollywood	*Cinnamomum baileyanum*		3.9		3.9
Box, grey	*Eucalyptus microcarpa*		3.5		3.5
Coastal grey box	*Eucalyptus bosistoana*			3.43	3.4
Brownbarrel	*Eucalyptus fastigata*		3.3		3.3
Brush box	*Tristania conferta*	4.6	3.9-4.6	4.55	4.5
Carabeen, yellow	*Sloanea woollsii*		4.4		4.4
P. Caribae	*Pinus caribaea*	5.31			5.3
Cedar, red, western	*Thuja plicata*		2.9-4.0	2.9-4.7	3.3
Chestnut	*Castanea sativa*		3.6		3.6

Common Name	Botanical Name	BCE	Bootle	Davis	Suggested Design pH
Coachwood	*Ceratopetalum apetalum*		5.0		5.0
Cypress	*Cupressus macrocarpa*	5.35			5.4
Elm	*Ulmus* spp		6.0-7.2	6.0-7.2	6.2
Fir, Douglas	*Pseudotsuga menziesii*	4.0	3.1-4.4		3.5
Douglas Fir, Oregon Pine	*Pseudotsuga menziesii*			3.1-4.4	3.5
Geronggang			2.6		2.6
Gum, grey	*Eucalyptus canaliculata*		3.8		3.8
Forest red gum	*Eucalyptus blakelyi*	4.96	3.7		4.2
Rose gum	*Eucalyptus grandis*	5.12			5.1
Mountain grey gum	*Eucalyptus cypellocarpa*			3.57	3.6
Sydney Blue gum	*Eucalyptus saligna*		3.6-4.2	3.65-3.80	3.6
Flooded gum	*Eucalyptus rudis*			3.84	3.8
Spotted gum	*Eucalyptus citriodora*	4.5	46-5.0	4.25-4.68	4.5
Hemlock, western	*Tsuga heterophylla*		4.8-5.4		4.9
Hickory	*Carya* spp		5.2		5.2
Iroko	*Chlorophora excelsa*		5.2-7.2		5.5
Red ironbark	*Eucalyptus crebra*	5.06	3.7	3.66	4.0
		4.1			4.0
Grey ironbark	*Eucalyptus drepanophylla*	5.82	3.7	4.88	4.0
Jarrah	*Eucalyptus marginata*		3.0-3.7	3.0-3.7	3.3
Jelutong	*Dyera costulata*		4.6	4.65	4.6
Kapur (Camphorwood)	*Cinnamomum oliveri*		3.2-3.7		3.3
Karri	*Eucalyptus diversicolor*	4.3	4.1	4.05	4.2
Kauri	*Agathis vitiensis*	5.2			5.2
Kempas			3.6-4.6		4.0
Keruing	*Dipterocarpus genus*		5.1		5.1
Larch, European	*Larix decidua*		4.0		4.0
Lignum vitae	*Guaiacum officinale*			3.6	3.6
LOSP		4.6			4.6
Mahogany, African	*Khaya ivorensis*		4.5-5.1		4.7
Mahogany, brush	*Geissois benthamii*		5.1		5.1
Mahogany, red	*Eucalyptus pellita*		2.4-3.4		3.0
Mahogany, rose	*Dysoxylum fraseranum*		4.0		4.0
Mahogany, white	*Eucalyptus acmenoides*		3.9	3.24	3.5
Cuban mahogany (sapwood)	*Swietenia* spp			2.75	2.7
(heartwood)				3.85	3.8
Maple, rose	*Cryptocarya erythroxylon*		5.5		5.5
Maple, sugar Queensland?	*Flindersia brayleyana*		5.0-5.8		5.4
Meranti	*Shorea* spp	3.9			3.9
Meranti, red, light	*Shorea* spp		4.3-6.1	5.2	5.0
Meranti, red, dark (sapwood)	*Shorea* spp		3.9-5.3	5.4	5.0
(heartwood)				3.85	3.9
Mercau Merbau?	*Pometia acuminata*		4.3		4.3

Common Name	Botanical Name	BCE	Bootle	Davis	Suggested Design pH
Mersawa	*Anisoptera* sp		4.3-4.6		4.5
Messmate	*Eucalyptus obliqua*		3.2		3.2
Oak, European	*Quercus ilex*		3.3-5.2		4.0
Oak, Japanese	*Quercus mongolica*		3.2-4.7		3.8
Southern Silky Oak	*Grevilla robusta*			4.95	4.9
Oregon	*Pseudotsuga taxifolia*	3.9			3.9
Peppermint	*Eucalyptus radiata*			3.15	3.2
Pine, cypress, white	*Callitris columellaris*		5.7		5.7
Pine, hoop	*Araucaria cunninghamii*		5.2		5.2
Pine, maritime	*Pinus pinaster*		3.8	3.8	3.8
Pine, radiata	*Pinus radiata*	5.0	4.0-4.8		4.8
Pine, Huon	*Dacrydium franklinii*	4.6			4.6
Pine, caribbean	*Pinus caribaea*			3.9	3.9
Pine, scots	*Pinus sylvestris*			4.3-4.6	4.5
Poplar	*Populus* spp		4.6-5.6		5.0
Ramin			5.2	5.25	5.2
Sacau (Fiji)		5.58			5.6
Sape?e Sapote?	*Calocarpus sapota*		5.3-4.6		5.0
Sassafras	*Daphnandra dielsii*		5.5		5.5
Seraya, white	*Shorea* spp		5.0-5.5		5.3
Spruce, Sitka	*Oicea sitchensis*		3.4-5.5		4.0
Sycamore	*Acer pseudoplatanus*		4.3-6.0		5.0
Tallowwood	*Eucalyptus microcorys*		3.6-3.8	3.55-3.56	3.5
Teak	*Tectona grandis*		4.5		4.5
Turpentine	*Syncarpia glomulifera*		3.6-3.9	3.21	3.5
Yellow stringybark	*Eucalyptus muellerana*	4.73		3.62	4.0
Yellowwood	*Flindersia xanthoxyla*		4.9-5.2		5.0

H3, CCA treated Radiata pine		4.8			na
H5, CCA treated Radiata pine		4.9			na

Figure 2.1 presents the distribution of the recommended pH values for design of all species listed in Table 2.1. From the figure, the acidity classification of timber is established according to the pH of the species, as defined in Table 2.2.

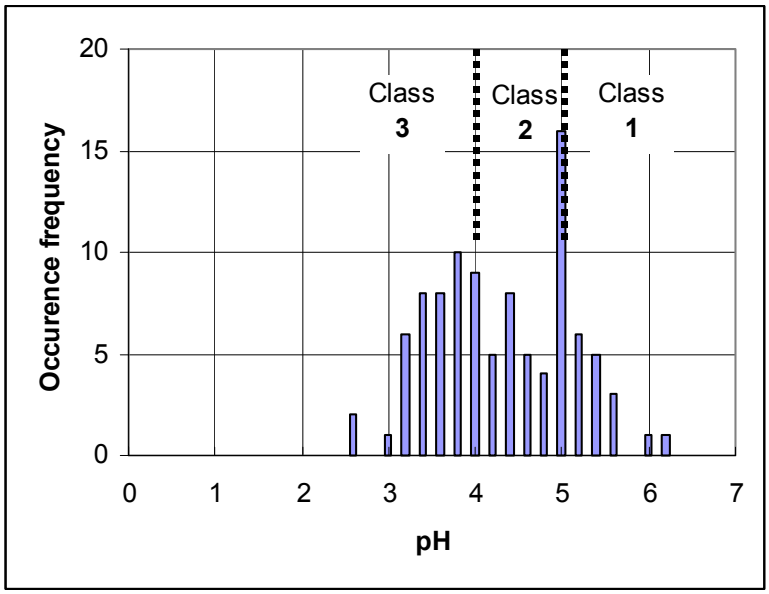

Figure 2.1 Histogram of pH values of all species in Table 2.1 and Natural Acidity Classification.

Table 2.2 Natural acidity classification and representative pH values

Acidity Class	Representative pH value	Boundary pH value
1	5.5	
		5.0
2	4.5	
		4.0
3	3.5	

There are 2 sources of timber species: Thornton's table (Thorton *et al.* 1997) currently implemented in the Timber Durability Database and TRADAC table (TRADAC 1999). Combination of the 2 tables results in the species list in Table 2.4. The pH values of many species in this list are available from Table 2.1 and also listed in the last column of Table 2.4

for reference. From the pH values, the ‘original ‘acidity class can be assigned for the tested species using the rule in Table 2.2.

However, to determine the acidity class of *all* species in the list, it is assumed that the natural acidity class correlates with the types of timber, which are divided into Eucalypts, Non-Eucalypt Hardwoods, and Softwoods. Figure 2.2 shows the Natural Acidity Class versus the density of the tested species separated into Eucalyptus, Non-Eucalyptus Hardwood and Softwood. It can be seen that the density of timber is not in good correlation with the acidity class. However, the Figure indicates that most of Eucalypts are of class 3, whereas the others are of class 2. Summary of the simplified classification and representative pH values for untested species are in Table 2.3.

Table 2.3 Acidity Classification according to types of wood for ALL species

Type of Wood	Acidity Class	Representative pH
Eucalypts	3	3.5
Non-Eucalypt Hardwoods	2	4.5
Softwoods	2	4.5

The Acidity classifications for all the species are listed in Table 2.4.

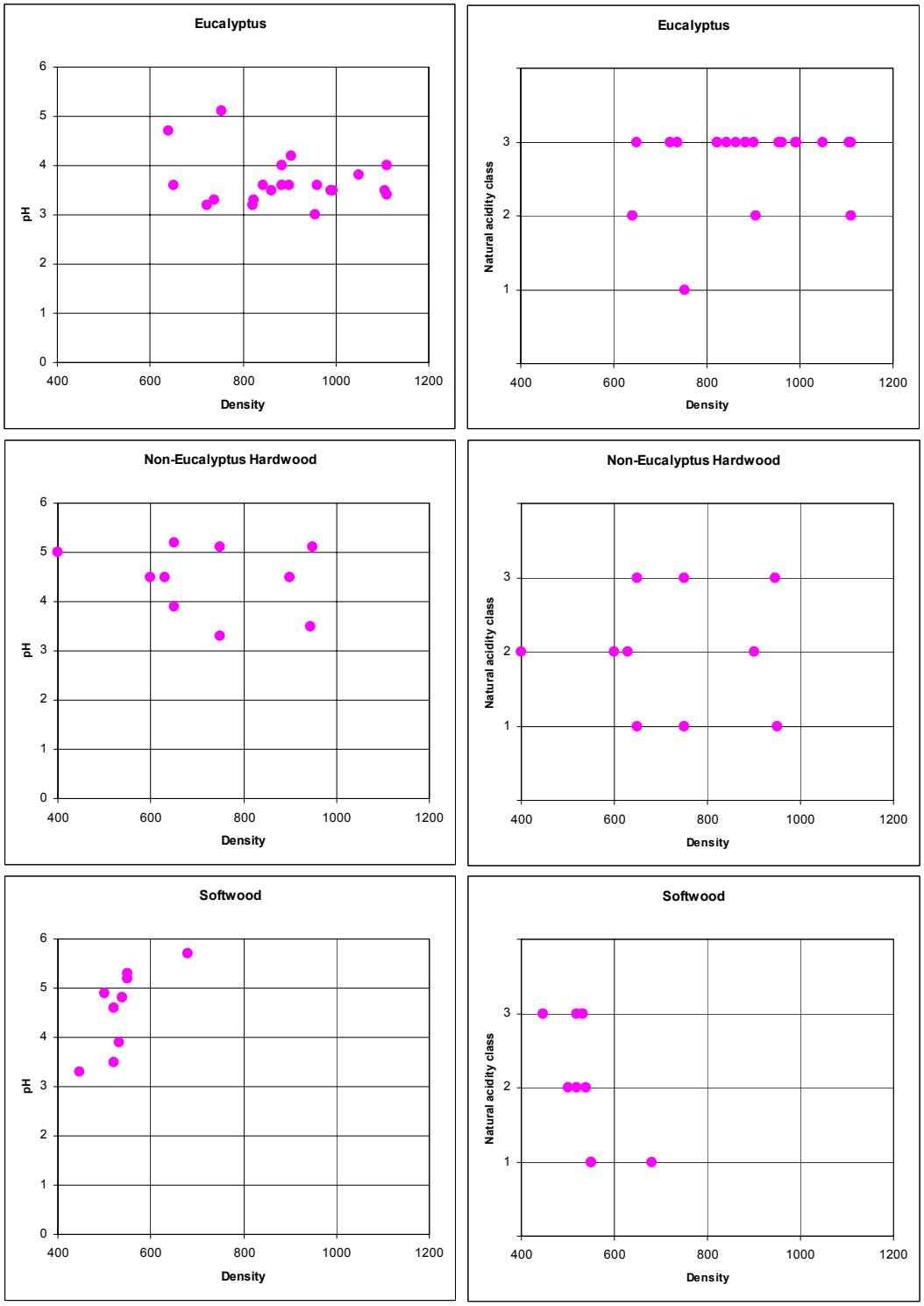

Figure 2. 2. Design pH and acidity class versus density of tested species grouped into Eucalyptus, Non-Eucalyptus Hardwood, and Softwood

Table 2.4 Natural acidity Classification

Standard Australia index	Trade name	Botanical name	Type	Density	Natural acidity class	Reference data derived from Table 2.1	
						Original natural acidity class	Design pH
22	Ash, alpine	Euc. delegatensis	E	650	3	3	3.6
25	Ash, crown	Flindersia australis	H	950	2	1	5.1
30	Ash, mountain	Euc. regnans	E	640	3	2	4.7
37	Ash, silvertop	Euc. sieberi	E	862	3	3	3.5
-	Balau (selangan batu)	Shorea spp.	H	900	2	-	-
-	Bangkirai	Shorea laevifolia	H	850	2	-	-
65	Beech, myrtle	Nothofagus cunninghamii	H	705	2	-	-
-	Belian (ulin)	Eusideroxylon zwageri	H	1000	2	-	-
84	Blackbutt	Euc. pilularis	E	884	3	3	3.6
86	Blackbutt, New England	Euc. andrewsii	E	850	3	-	-
87	Blackbutt, WA	Euc. patens	E	849	3	-	-
88	Blackwood	Acacia melanoxylon	H	650	2	-	-
97	Bloodwood, red	Euc. gummifera	E	900	3	3	3.6
90	Bloodwood, white	Euc. trachyphloia	E	1023	3	-	-
109	Bollywood	Litsea reticulata	S	532	2	3	3.9
121	Box, brush	Lophostemon confertus	H	900	2	2	4.5
126	Box, grey	Euc. moluccana	E	1105	3	3	3.5
127	Box, grey, coast	Euc. bosistoana	E	1110	3	3	3.4
134	Box, long leaved	Euc. goniocalyx	E	873	3	-	-
138	Box, red	Euc. polyanthemos	E	1064	3	-	-
144	Box, steel	Euc. rummeryi	E	0	3	-	-
145	Box, swamp	Lophostemon suaveolens	H	850	2	-	-
150	Box, yellow	Euc. melliodora	E	1075	3	-	-
148	Box,white	Euc. albens	E	1112	3	-	-
162	Brigalow	Acacia harpophylla	H	1099	2	-	-
165	Brownbarrel	Euc. fastigata	E	738	3	3	3.3
167	Bullich	Euc. megacarpa	E	640	3	-	-
-	Calantas (kalantas)	Toona calantas	H	500	2	-	-
178	Candlebark	Euc. rubida	E	750	3	-	-
73	Cedar, red, western	Thuja plicata	S	448	2	3	3.3
544	Cypress	Callitris Glaucophylla	S	680	2	1	5.4
114	Fir, Douglas	Pseudotsuga menziesii	S	520	2	3	3.5
253	Gum, blue, southern	Euc. globulus	E	900	3	-	-
254	Gum, blue, Sydney	Euc. saligna	E	843	3	3	3.6
266	Gum, grey	Euc. propinqua	E	1050	3	3	3.8
267	Gum, grey, mountain	Euc. cypellocarpa	E	961	3	3	3.6
268	Gum, maiden's	Euc. maidenii	E	992	3	-	-
269	Gum, manna	Euc. viminalis	E	814	3	-	-
272	Gum, mountain	Euc. dalrympleana	E	700	3	-	-
281	Gum, red, forest	Euc. tereticornis	E	737	3	-	-
281	Gum, red, river	Euc. camaldulensis	E	913	3	-	-
284	Gum, rose	Euc. grandis	E	753	3	1	5.1
286	Gum, salmon	Euc. salmonophloia	E	1070	3	-	-

288	Gum, scribbly	Euc. haemastoma	E	907	3	-	-
289	Gum, shining	Euc. nitens	E	530	3	-	-
293	Gum, spotted	Euc. maculata	E	988	3	-	-
294	Gum, sugar	Euc. cladocalyx	E	1105	3	-	-
305	Gum, yellow	Euc. leucoxylon	E	1008	3	-	-
310	Hardwood, Johnstone River	Backhousia bancroftii	H	950	2	-	-
-	Hemlock, western	Tsuga heterophylla	S	500	2	2	4.9
322	Ironbark, grey	Euc. paniculata	E	1110	3	2	4.0
325	Ironbark, red	Euc. sideroxylon	E	1086	3	-	-
326	Ironbark, red (broad-leaved)	Euc. fibrosa	E	1116	3	-	-
327	Ironbark, red (narrow-leaved)	Euc. crebra	E	1046	3	3	4.0
336	Ironwood Cooktown	Erythrophleum chlorostgchys	H	1220	2	-	-
340	Jam, raspberry	Acacia acuminata	H	1038	2	-	-
341	Jarrah	Euc. marginata	E	823	3	3	3.3
-	Kapur	Dryobalanops spp.	H	750	2	3	3.3
344	Karri	Euc. diversicolor	E	905	3	2	4.2
	Keruing	Dipterocarpus spp.	H	750	2	1	5.1
173	Kwila	Intsia bijuga	H	825	2	-	-
-	Mahogany, Philippine, red, dark	Shorea spp.	H	650	2	-	-
-	Mahogany, Philippine, red, light	Shorea, Pentacme, Parashorea spp.	H	550	2	-	-
384	Mahogany, red	Euc. resinifera	E	955	3	3	3.0
391	Mahogany, white	Euc. acmenoides	E	993	3	3	3.5
391	Mahogany, white	Euc. umbra	E	887	3	-	-
387	Mahonany, southern	Euc. botryoides	E	919	3	-	-
411	Mallet, brown	Euc. astringens	E	974	3	-	-
432	Marri	Euc. Calophylla	E	855	3	-	
-	Meranti, red, dark	Shorea spp.	H	650	2	3	3.9
-	Meranti, red, light	Shorea spp.	H	400	2	2	5.0
226	Mersawa (Garawa)	Anisoptera thyrifera	H	630	2	2	4.5
434	Messmate	Euc. obliqua	E	722	3	3	3.2
435	Messmate, Gympie	Euc. cloeziana	E	996	3	-	-
458	Oak, bull	Allocasuarina luehmannii	H	1050	2	-	-
240	Oak, white, American	Quercus alba	H	750	2	-	-
509	Peppermint, black	Euc. amygdalina	E	753	3	-	-
510	Peppermint, broad leaved	Euc. dives	E	811	3	-	-
512	Peppermint, narrow leaved	Euc. radiata	E	822	3	3	3.2
515	Peppermint, river	Euc. elata	E	804	3	-	-
529	Pine, black	Prumnopitys amara	S	500	2	-	-
533	Pine, caribbean	Pinus caribaea	S	550	2	1	3.9
534	Pine, celery-top	Phyllocladus asplenifolius	S	646	2	-	-
545	Pine, hoop	Araucaria cunninghamii	S	550	2	1	5.2
546	Pine, Huon	Lagarostrobos franklinii	S	520	2	2	4.6
548	Pine, kauri	Agathis robusta	S	503	2	-	-
549	Pine, King William	Athrotaxis selaginoides	S	400	2	-	-
559	Pine, radiata	Pinus radiata	S	540	2	2	4.8
561	Pine, slash	Pinus elliotii	S	650	2	-	-

-	Ramin	Gonystylus spp.	H	650	2	1	5.2
326	Redwood	Sequoia sempervirens	S	400	2	-	-
332	Rosewood, New Guinea	Pterocarpus indicus	H	577	2	-	-
635	Satinay	Syncarpia hillii	H	838	2	-	-
668	Stringybark, Blackdown	Euc. sphaerocarpa	E	1000	3	-	-
671	Stringybark, brown	Euc. capitellata	E	838	3	-	-
676	Stringybark, red	Euc. macrorhyncha	E	899	3	-	-
680	Stringybark, white	Euc. Eugenioides 2	E	856	3	-	-
680	Stringybark, White (Wilkinson's)	Euc. Eugenioides 1	E	856	3	-	-
681	Stringybark, yellow	Euc. muelleriana	E	884	3	3	4
688	Tallowwood	Euc. microcorys	E	990	3	3	3.5
-	Taun	Pometia pinnata	H	700	2	-	-
369	Teak, Burmese	Tectona grandis	H	600	2	2	4.5
713	Tingle, red	Euc. jacksonii	E	772	3	-	-
714	Tingle, yellow	Euc. guilfoylei	E	900	3	-	-
720	Tuart	Euc. gomphocephala	E	1036	3	-	-
723	Turpentine	Syncarpia glomulifera	H	945	2	3	3.5
747	Wandoo	Euc. wandoo	E	1099	3	-	-
774	Woolybutt	Euc. longifolia	E	1068	3	-	-
780	Yate	Euc. cornuta	E	1100	3	-	-
788	Yertchuk	Euc. consideniana	E	939	3	-	-

3. Timber Classification for Marine Borer Attack

Classification of heartwood timber is shown in Table 3.1. The species are classified into 4 marine-borer durability classes based on the rating of the performance of 4-year trial clear specimens tests at 3 sites, including Port Stephens (NSW), Williamstown (VIC) and Geelong (VIC) (Cookson & Scown, 2003)

Code for information sources used in table:

A = Marine natural durability test at 3 sites (Melbourne, Geelong, Port Stephens) (Cookson & Scown, 2003)

B = Calibration report and personal observations

C = Cookson (1996). An aquaria test of the natural resistance against marine borers of some commercial timber available in Australia. IRG/WP/96-10145.

D = Watson, C.J.J, McNeill, F.A., Johnson, R.A., Iredale, T. (1936). Destruction of timber by marine organisms in the Port of Brisbane. Queensland Forest Service, Bulletin No. 12.

E = Johnson, R.A. and Moore, D.D. (1950). The natural resistance of timber to marine borer attack. Western Australian timbers. Port of Sydney Journal 3 (2): 55-57.

F = Shillinglaw, A.W. and Moore, D.D. (1947). Report of marine borer survey in New Guinea waters. CSIR Bulletin No. 223.

G = Table provided by the Maritime Services Board, Sydney.

H = Assume all timbers with in-ground natural durability of 3 or 4 will be 4 for marine.

J = Choon, L.W. and Cookson, L.J. (1996). Laboratory study on the natural durability of Sarawak timbers against marine borers. TRTTC Technical Report No. TR/18 (bioassay conducted at same time as C above).

Table 3.1 Classification of heartwood against marine borer attack

Trade name	Botanical name	Marine Borer Durability Class	Source (see text)
Alder, blush	*Sloanea australis*	4	H
Alder, brown	*Caldcluvia paniculosa*	4	H
Alder, pink	*Gillbeea adenopetala*	4	H
Alder, rose	*Caldcluvia australiensis*	4	H
Amberoi	*Pterocymbium* spp.	4	H
Apple, rough-barked	*Angophora floribunda*	4	H
Apple, smooth-barked	*Angophora costata*	4	G
Ash, alpine	*Eucalyptus delegatensis*	4	G
Ash, Blue Mountains	*Eucalyptus oreades*	4	G
Ash, Crow's	*Flindersia australis*	4	G
Ash, mountain	*Eucalyptus regnans*	4	A
Ash, pink	*Alphitonia petriei*	4	H
Ash, silver	*Flindersia bourjotiana, Flindersia schottiana*	4	H
Ash, silvertop	*Eucalyptus sieberi*	4	A
Ash, white	*Eucalyptus fraxinoides*	4	H
Baltic, red (pine, Scots)	*Pinus sylvestris*	4	H
Baltic, white (spruce, Norway)	*Picea abies*	4	H
Beech, myrtle	*Nothofagus cunninghamii*	4	H
Beech, negrohead	*Nothofagus moorei*	4	H
Beech, silver	*Nothofagus menziesii*	4	H
Belian	*Eusideroxylon zwageri*	1	J
Birch, white, Australia	*Schizomeria ovata*	4	H
Blackbutt	*Eucalyptus pilularis*	3	A
Blackbutt, New England	*Eucalyptus andrewsii, Eucalyptus campanulata*	2	A
Blackbutt, Western Australian	*Eucalyptus patens*	3	E
Blackwood	*Acacia melanoxylon*	4	C
Bloodwood, red	*Corymbia gummifera, Eucalyptus intermedia* *Eucalyptus polycarpa*	3	D
Bollywood	*Cinnamomum baileyanum, Litsea* spp.	4	H
Box, brush	*Lophostemon confertus*	2	A,D
Box, grey	*Eucalyptus macrocarpa, Eucalyptus moluccana* *Eucalyptus woollsiana*	2	A
Box, grey, coast	*Eucalyptus bosistoana*	3	B
Box, ironwood	*Choricarpia leptopetala* *Choricarpia subargentea*	4	H
Box, kanuka	*Tristania exiliflora, Tristania laurina*	4	H
Box, long-leaved	*Eucalyptus goniocalyx*	4	H
Box, swamp	*Lophostemon suaveolens*	2	D

Brownbarrel	*Eucalyptus fastigata*	4	G
Bullich	*Eucalyptus megacarpa*	4	H
Calophyllum	*Calophyllum* spp.	4	H
Candlebark	*Eucalyptus rubida*	4	H
Carabeen, yellow	*Sloanea woolsii*	4	H
Cedar, red	*Toona australis*	4	G
Cedar, western red	*Thuja plicata*	4	H
Cheesewood, white	*Alstonia scholaris*	4	H
Coachwood	*Ceratopetalum apetalum*	4	H
Cypress, black	*Callitris endlicheri*	3	C,G
Cypress, white	*Callitris glaucophylla*	2	B,C,D
Fir, amabilis	*Abies amabilis*	4	H
Fir, Douglas (oregon)	*Pseudotsuga menziesii*	4	C
Geronggang	*Cratoxylon arborescens*	4	H
Gum, blue, southern	*Eucalyptus globulus*	4	A
Gum, blue, Sydney	*Eucalyptus saligna*	3	A
Gum, grey	*Eucalyptus canaliculate, Eucalyptus major Eucalyptus propinqua, Eucalyptus punctata*	2	A
Gum, grey, mountain	*Eucalyptus cypellocarpa*	4	A
Gum, Maiden's	*Eucalyptus maidenii*	4	H
Gum, manna	*Eucalyptus viminalis*	4	H
Gum, mountain	*Eucalyptus dalrympleana*	4	G
Gum, pink	*Eucalyptus fasciculosa*	4	H
Gum, poplar	*Eucalyptus alba*	4	H
Gum, red, forest	*Eucalyptus blakelyi, Eucalyptus tereticornis*	2	D
Gum, red, river	*Eucalyptus camaldulensis*	2	A
Gum, rose	*Eucalyptus grandis*	4	A
Gum, round-leaved	*Eucalyptus deanei*	4	H
Gum, shining	*Eucalyptus nitens*	4	H
Gum, spotted	*Corymbia maculate, Corymbia citriodora Eucalyptus henryi*	4	A,D
Gum, swamp	*Eucalyptus camphora*	4	H
Gum, white, Dunn's	*Eucalyptus dunnii*	4	H
Gum, yellow	*Eucalyptus leucoxylon*	4	H
Hardwood, Johnston River	*Backhousia bancroftii*	4	H
Hemlock, western	*Tsuga heterophylla*	4	4
Iroko	*Chlorophora excelsa*	1	A
Ironbark, grey	*Eucalyptus drepanophylla, Eucalyptus paniculate, Eucalyptus siderophloia*	3	A
Ironbark, red	*Eucalyptus sideroxylon*	2	A
Jam, raspberry	*Acacia acuminata*	2	E

Jarrah	*Eucalyptus marginata*	3	A,B
Jelutong	*Dyera costulata*	4	H
Kamarere	*Eucalyptus deglupta*	4	H
Kapur	*Dryobalanops* spp.	4	H
Karri	*Eucalyptus diversicolor*	4	A,B
Kauri, New Zealand	*Agathis australis*	4	G
Kauri, Queensland	*Agathis atropurpurea, Agathis microstachya Agathis robusta*	4	G
Kempas	*Koompassia malaccensis*	4	H
Keruing	*Dipterocarpus* spp.	4	H
Kwila (merbau)	*Intsia bijuga*	3	C
Lumbayau (mengkulang)	*Heritiera* spp.	4	H
Mahogany, African	*Khaya* spp.	4	H
Mahogany, American	*Swietenia mahogani*	4	H
Mahogany, brush	*Geissois benthamii*	4	H
Mahogany, red	*Eucalyptus pellita, Eucalyptus resinifera*	2	C
Mahogany, red, Philippine,	*Shorea* spp.	4	H
Mahogany, southern	*Eucalyptus botryoides*	4	H
Mahogany, white	*Eucalyptus acmenoides, Eucalyptus tenuipes Eucalyptus umbra* subsp. *Carnea*	2	A,G
Malas	*Homalium foetidum*	4	H
Mallet, brown	*Eucalyptus astringens*	4	H
Malletwood	*Rhodamnia argentea, Rhodamnia costata*	4	H
Malletwood, brown	*Rhodamnia rubescens*	4	H
Malletwood, silver	*Rhodamnia acuminata*	4	H
Mangrove, grey	*Avicennia marina*	4	D
Maple, Queensland	*Flindersia brayleyana*	4	H
Maple, rose	*Cryptocarya erythroxylon*	4	H
Maple, scented	*Flindersia laevicarpa*	4	H
Maple, sugar (rock)	*Acer saccharum*	4	H
Marri	*Corymbia calophylla, Eucalyptus calophylla*	4	A
Meranti, bakau	*Shorea* spp.	4	H
Meranti, dark-red	*Shorea* spp.	4	H
Meranti, light-red	*Shorea* spp.	4	H
Meranti, white	*Shorea* spp.	4	H
Meranti, yellow	*Shorea* spp.	4	H
Mersawa	*Anisoptera* spp.	4	H
Messmate	*Eucalyptus obliqua*	4	A,B
Nyatoh	*Palaquium* and *Payena* spp.	4	H
Oak, silky, northern	*Cardwellia sublimis*	4	H
Oak, tulip, blush	*Argyrodendron actinophyllum*	4	H

Oak, tulip, brown	*Argyrodendron polyandrum* *Argyrodendron trifoliolatum*	4	H
Oak, tulip, red	*Argyrodendron peralatum,*	4	H
Oak, white, American	*Quercus alba*	4	H
Paulownia	*Paulownia* spp.	4	H
Penda, brown	*Xanthostemon chrysanthus*	2	F
Penda, red	*Xanthostemon whitei*	2	F
Penda, southern	*Xanthostemon, oppositifolius*	2	F
Penda, yellow	*Ristantia pachysperma*	2	D
Peppermint, black	*Eucalyptus amygdalina*	4	H
Peppermint, broad-leaved	*Eucalyptus dives*	4	H
Peppermint, narrow-leaved	*Eucalyptus Australiana, Eucalyptus radiata* *Eucalyptus robertsonii*	4	H
Peppermint, river	*Eucalyptus elata*	4	H
Peppermint, white	*Eucalyptus pulchella*	4	H
Pine, brown	*Podocarpus elatus*	3	D
Pine, bunya	*Araucaria bidwillii*	4	H
Pine, Canary Island	*Pinus canariensis*	4	H
Pine, Caribbean	*Pinus caribaea*	4	H
Pine, celery-top	*Phyllocladus asplenifolius*	4	H
Pine, Corsican	*Pinus nigra*	4	H
Pine, hoop	*Araucaria cunninghamii*	4	G
Pine, Huon	*Lagarostrobos franklinii*	4	C,D
Pine, King William	*Athrotaxis selaginoides*	4	C
Pine, klinki	*Araucaria hunsteinii*	4	H
Pine, loblolly	*Pinus taeda*	4	H
Pine, longleaf	*Pinus palustris*	4	H
Pine, maritime	*Pinus pinaster*	4	H
Pine, NZ white (kahikatea)	*Dacrycarpus dacrydioides*	4	H
Pine, patula	*Pinus patula*	4	H
Pine, ponderosa	*Pinus ponderosa*	4	H
Pine, radiata	*Pinus radiata*	4	B,C
Pine, Scots	*Pinus sylvestris*	4	H
Pine, slash	*Pinus elliottii*	4	H
Pine, white, western	*Pinus monticola*	4	H
Planchonella	*Planchonella chartacea*	4	H
Poplar, balsam	*Populus* spp.	4	H
Poplar, pink	*Euroschinus falcata*	4	H
Quandong, silver	*Elaeocarpus angustifolius, Elaeocarpus grandis*	4	H
Ramin	*Gonystylus* spp.	4	H
Redwood	*Sequoia sempervirens*	4	G

Rimu	*Dacrydium cupressinum*	4	H
Rosewood, New Guinea	*Pterocarpus indicus*	4	H
Sassafras	*Daphnandra dielsii, Daphnandra micrantha Daphnandra repandula, Doryphora aromatica Doryphora sassafras*	4	G
Satinash, grey	*Syzygium claviflorum,, Syzygium gustavioides*	4	H
Satinash, rose	*Syzygium crebrinerve, Eugenia francisii*	4	H
Satinay	*Syncarpia hillii*	1	D
Sepetir	*Copaifera* spp., *Pseudosindora* spp., *Sindora* spp.	4	H
Sheoak, beach	*Allocasuarina equisetifolia*	4	H
Sheoak, black	*Allocasuarina littoralis*	4	G
Silkwood, maple	*Flindersia pimenteliana*	4	H
Spruce, Norway	*Picea abies*	4	H
Spruce, Sitka	*Picea sitchensis*	4	H
Stringybark, blue-leaved	*Eucalyptus agglomerata*	4	H
Stringybark, brown	*Eucalyptus baxteri, Eucalyptus blaxlandii Eucalyptus capitellata*	4	H
Stringybark, diehard	*Eucalyptus cameronii*	4	H
Stringybark, red	*Eucalyptus macrorhyncha*	3	C
Stringybark, silvertop	*Eucalyptus laevopinea*	4	H
Stringybark, white	*Eucalyptus eugenioides, Eucalyptus globoidea Eucalyptus phaeotricha*	3	A,G
Stringybark, yellow	*Eucalyptus muelleriana*	3	A
Sycamore, silver	*Cryptocarya glaucescens*	4	H
Tallowwood	*Eucalyptus microcorys*	3	A
Taun	*Pometia* spp.	4	H
Tea-tree, broad-leaved	*Melaleuca leucadendron, Melaleuca quinquenervia, Melaleuca viridiflora*	3	D
Tea-tree, river	*Melaleuca bracteata*	4	H
Tingle, red	*Eucalyptus jacksonii*	4	H
Touriga, red	*Calophyllum costatum*	4	H
Tuart	*Eucalyptus gomphocephala*	4	E
Turpentine	*Syncarpia glomulifera*	1	A,B
Walnut, New South Wales	*Endiandra virens*	4	H
Walnut, Queensland	*Endiandra palmerstonii*	4	H
Walnut, yellow	*Beilschmiedia bancroftii*	4	H
Wandoo	*Eucalyptus wandoo*	3	E
Yate, swamp	*Eucalyptus occidentalis*	4	E

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