ALTERNATIVE TIMBERS

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SUMMARY

This paper gives guidance on what structural properties and durability to expect from New Zealand-grown species that are not listed in NZS3603. For structural properties the derivation of characteristic stresses from small clears data is described. Because the property that usually determines the size of member required is modulus of elasticity, the mean small clears value is applied directly. For durability, the species are listed in four classes, according to observed performance of those species in ground contact.

INTRODUCTION

Mike Collins published an article in the TDS journal in 1997 [1]. This was written in response to the numerous enquiries from people who wanted to use some timber other than the species listed in NZS3603. There were generally two questions:

- How strong/stiff is it?
- How durable is it?

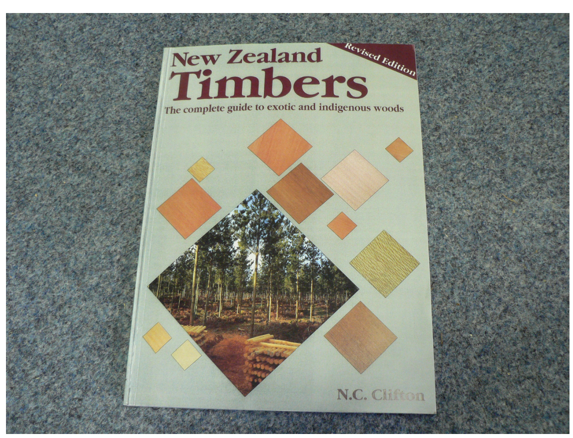
Mike's paper addressed the first question, and his approach was to provide an equivalence or adjustment to the tables in NZS3604, on the basis of modulus of elasticity alone, since that was the governing property in practically every case.

This paper will attempt to address both issues. The question of structural adequacy is probably easy, one that can be answered from several resources. Advice on durability relies more on experience than hard data.

Today NZS3603 lists only radiata pine and Douglas fir but in 1997 more species were listed even though radiata pine and Douglas fir were the only species readily available then. The usual situations that gave rise to the requests were where someone wanted to mill and use timber from a small woodlot on their property or a designer had the task of evaluating the structural condition of an historic building made with native timbers.

DATA SOURCES

The best advice currently available is in "New Zealand Timbers" by N.C. Clifton [2]. In Part 1 general coverage is given several of topics, namely:



- Hardwood and softwoods
- Heartwood, sapwood and natural durability
- Growth rings
- Moisture content
- Wood density

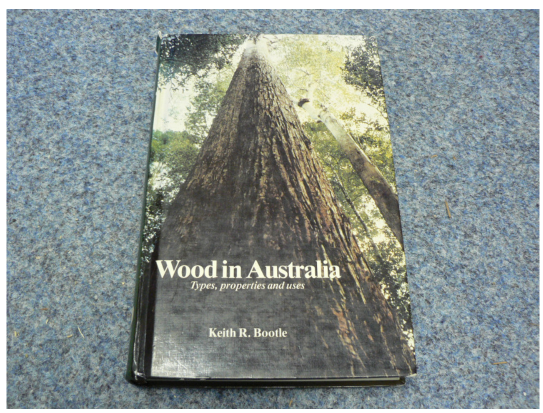
- Shrinkage
- Collapse (a drying phenomenon)
- Reaction wood
- Growth stresses
- Mould and sapstain
- Decay
- Insect borers
- Drying
- Preservative treatment
- Exterior finishes

In Part 2, fifty-seven species are described, giving particulars about:

- The tree
- The wood
- Use background
- Physical and mechanical properties
- Drying
- Preservative treatment
- Availability.

This book is available from the library at Scion for $63 including GST.

Another good source that covers timber found on the Australian market is "Wood in Australia" by Keith Bootle [3]. This has the same layout of general information in Part 1 and species-specific information in Part 2. The general section is more extensive than in Norm Clifton's book, covering:



- The nature of wood
- Colour changes in wood
- Mechanical properties of timber
- Other properties of timber
- Corrosion aspects of wood use
- Conversion of tree to timber
- Drying of wood
- The joining of timber components
- Plywood
- Reconstituted wood products
- Pulp and paper
- Bending of wood
- Bleaching and stain removal
- Coatings
- Destroyers of timber
- Preservation methods
- Use of sawmill residues
- Wood as fuel
- Health problems in wood processing
- Some wood utilization aspects of tree breeding
- Australian Standards for the timber industry.

Part 2 describes 381 species, listing:

- Size of tree and type of forest (location)
- Description of the wood
- Density
- Drying and shrinkage characteristics
- Workability
- Durability
- Strength grouping
- Uses
- Availability
- An extensive table of mechanical properties

STRUCTURAL PROPERTIES

Hank Bier described the derivation of design properties from small clears data in his paper to the 1984 Pacific Timber Engineering Conference [4]. At that time the Working Stress design (WSD) method was used so for bending and compression the mean strength or stiffness (M) was multiplied by factors to account for variability (K_v), safety (K_s), load duration (K_d) and grade (R) to derive basic working stresses. When the conversion was made to Limit States Design (LDS), the strength values were multiplied by 2.95

Hence for strength properties $F' = 2.95 M k_v k_s k_d R$.

Variability. The lower 1%ile value was computed assuming a normal distribution.
Hence $k_v = 1 - 2.33V$, where V is a typical coefficient of variation for that property. V is assumed to be 0.16 in bending and 0.18 in compression [5].

Safety. A factor of safety of 0.8 was applied to bending and compression values

Load duration. A factor of 0.56 was applied to convert the short term small clear value to a permanent loading for bending and 0.75 for compression.

Grade. A ratio was defined as the average property of structural timber containing defects of the limiting size allowed in a particular grade, divided by the average property of small clears cut from that timber. This ratio included whatever size effects existed between small clear and structural sizes. If a designer is faced with the problem of assessing an existing structure then an inspection will be necessary to determine the appropriate grade. Completely clear (defect-free) timber could be expected to have a strength ratio of 1.0 but size effects would probably reduce that to 0.8. Engineering grade, which allows knots up to 20% of the width within the margins and 30% between the margins, has a strength ratio of 0.65 in bending. The strength ratio in compression is taken as the square root of the ratio in bending. For E the strength ratio is usually taken as 1.0 and lower bound MoE as $0.67E$.

A summary of the derivation is given in Table 1.

In most cases the critical property is modulus of elasticity so the mean small clear value is all the designer needs.

The issue of verification does not arise because that was introduced to deal with problems of variable properties in radiata pine.

Table 1. Derivation of characteristic stresses from small clears data.

Char. stress	Strength ratio	Load duration	Safety	Variability	Mean test value	LSD conversion	Expression
f_b	R	0.56	0.8	(1-2.33V)	M_b	2.95	$= 0.83RM_b$
E	R				M_E	1.0	$= RM_E$
f_t							$= 0.8f_b$*
f_c	R	0.75	0.8	(1-2.33V)	M_c	2.95	$= 1.03RM_c$
f_p	0.75	0.75			M_p	2.95	$= 1.66M_p$
f_s	0.75	0.2			M_s	2.95	$= 0.44M_s$

*In later revisions f_t has been set equal to $0.5f_b$ based on tests of framing sizes of timber.

Table 2. In-ground natural durability classification of New Zealand-grown species.

	Class 1 >25 years	Class 2 15 – 25 years	Class 3 5 – 15 years	Class 4 <5 years
Hardwoods	Robinia *E. cladcalyx* *E. cornuta*	Hard beech Mountain beech Red beech Southern rata *E. amygdalina* *E. botryoides* *E. globoidea* *E. muellerana* *E. pilularis* *E. saligna* *E. microcorys* *E. radiata*	Hinau[1] Mangeao[1] Pukatea[1] *E. regnans*[1] *E. viminalis*[1] Silver beech[1] *E. delegatensis*[1] *E. pyrocarpa*[1] *E. obliqua*[1] Blackwood[1] Black beech[2] Chestnut[2]* *E. glogulus*[2] *E. sieberi*[2] *Gleditsia tricanthos*[2]	Tawa Silver birch *Pawlonia tomentosa* *Pawlonia elongata*
Softwoods	Silver pine Totara		Miro[1] Matai[1] Kauri[1] Muricata pine[1] Radiata pine[1] Strobus pine[1] Lodegpole pine[1] Douglas fir[1] Kaikawaka[2] Tanekaha[2] Rimu[2] Macrocarpa[2] Lusitanica[2] Lawson's cypress[2] Western red cedar[2] Japanese cedar[2]	Corsican pine Ponderosa pine

Notes: 1 Lower end of range 2 Upper end of range

DURABILITY RATINGS

Norm Clifton's book contains a table with five durability ratings, from "Perishable" to "Very durable". In the process of joint standardization with Australia, this has been reduced to four classes, as shown in Table 2, taken from [6]. Note that the classification refers to in-ground contact. For exterior out-of-ground contact the species will shift up one class. For interior uses all the timbers are effectively class 1 rating. In terms of the current building code, those species towards the upper end of the range in class 3, are considered equivalent to H3.1.

REFERENCES

1 Collins M.J. 1997. Alternatives to radiata pine for house framing to NZS3604. NZ Timber Design Journal, Vol. 6, Issue 2, pp14-24.

2 Clifton N.C. 1994. New Zealand timbers. GP Publications, Wellington, ISBN 1 86956 1147

3 Bootle Keith R. 1983. Wood in Australia. McGraw-Hill Book Co. Sydney, ISBN 0 07 451047 9

4 Bier H. Derivation of timber design stresses in New Zealand. *In proceedings of* Pacific Timber Engineering Conference, pp760-767

5 ASTM D2555. 1982. Standard methods for establishing clearwood strength values. Annual book of ASTM Standards, Part 22.

6 Page D., Foster J. and Hedley M. 1997. Naturally durable wood – is it a practical alternative to preservative treated pine? What's new in Forest Research No. 245, NZ Forest Research Institute.