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Naturally durable wood — is it a practical alternative to preservative-treated pine?

Houses clad with preservative-treated radiata pine (left), and naturally durable macrocarpa (right).

With increasing awareness of potential adverse effects of toxic chemicals on the environment, growing and using naturally durable timbers is an attractive alternative to the use of preservative-treated timber. The New Zealand Building Code allows a 15-year life for constructional timbers not used in critical situations — a life well within the scope of many species capable of being grown in New Zealand.

But which species and for what uses?

Resistance to fungal and insect attack is only one property which can affect fitness for purpose. Stability, machining or working properties, and resistance to weathering must all be taken into account, and these attributes vary enormously from species to species. For example, *Eucalyptus cladocalyx* has been found to be very durable in ground contact, but its extreme density makes driving staples into it almost impossible and hence its suitability for fence posts is questionable.

Tests have been undertaken at FRI on various untreated species to determine their suitability for such uses as fence posts, fence battens, decking, weatherboards and roofing shingles. However, although a particular species may perform well in these tests, there may be silvicultural factors, such as susceptibility of the growing tree to fungal diseases or insect attack, poor site and establishment, which could well restrict widespread planting and subsequent utilisation.

Durability in ground contact

Traditionally, natural durability has been assessed by placing stakes (usually 20 mm or 50 mm square) in the ground and recording the time (measured in years) taken for them to fail through decay. This is determined by removing the stake and rapping one end firmly on the ground. Failure is recorded if the stake breaks. Only heartwood is used in these tests, since the sapwood of all species is non-durable.

Table 1 shows the natural durability classifications of species tested in New Zealand ranked, depending on times to failure, into four classes (the customary Australian classification system). In compiling this table, differences in size of specimens (20 x 20 mm stakes, 50 x 50 mm stakes, 100 mm diameter posts) are taken into account, since for any particular species, the bigger the size, the longer the time to failure.

Species rated Class 1 or 2 would be suitable for fence posts, but while researchers are examining the feasibility of growing totara as a plantation species, currently only the hardwoods seem a practical option.

Table 1 categorises the "average" natural durability of species. Unfortunately, for most species, durability is a property which can vary from tree to tree. This is illustrated in Table 2 which shows the number of stakes (out of 10 per tree originally installed) cut from five 18-year old trees of three *Eucalyptus* species remaining after 14 years in the ground. The average life is calculated when all stakes in a set have failed.

On the basis of this test to date, it would be difficult to decide which of these species is the best option for utilisation:

- *E. pilularis* has 10 specimens left from 3 different trees, and the average life so far determined (from 2 trees) is 6.3 years.
- *E. muelleriana* has only 6 specimens left spread evenly over 4 trees with an average life established from 1 tree of 8 years.
- *E. globoidea* has 13 specimens left, 10 of which are from 2 trees, but average life from 1 tree was only 4 years.

Thus, while the wood from some trees will perform adequately, there is no guarantee that every tree of a given species will provide durable wood.

Table 1. In-ground natural durability classification of NZ-grown species (*E.* = *Eucalyptus*).

	Class 1 **> 25 years**	**Class 2** **15 - 25 years**	**Class 3** **5-15 years**	**Class 4** **< 5 years**
Hardwoods	Robinia *E. cladocalyx* *E. cornuta*	Hard beech Mountain beech Red beech Southern rata *E. amygdalina* *E. botryoides* *E. globoidea* *E. muelleriana* *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. globulus* [2] *E. sieberi* [2] *Gleditsia triacanthos* [2] *	Tawa Silver birch *Paulownia tomentosa* *Paulownia elongata*
Softwoods	Silver pine Totara		Miro[1] Matai[1] Kauri[1] Muricata pine [1] Radiata pine [1] Strobus pine [1] Lodgepole 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

[1] **Lower end of range.** [2] **Upper end of range.** * **Provisional, based on incomplete tests.**

Table 2. Performance of stakes cut from 5 trees, after 14 years in the ground.

Species	**Tree 1**	**Tree 2**	**Tree 3**	**Tree 4**	**Tree 5**	**Total stakes remaining per species**
E. pilularis	5	0 (av. life 7 yr)	3	0 (av. life 5.7 yr)	2	10
E. muelleriana	2	1	2	1	0 (av. life 8 yr)	6
E. globoidea	4	6	2	0 (av. life 4 yr)	1	13

Above-ground durability

Durability Class 3 contains species which would have sufficient durability for many above-ground situations, although they might not have necessary physical properties for all of them — for example, low density and low strength/stiffness limit utilisation of Japanese cedar and western red cedar. This class also has species at the lower end of the range, which would have only limited application — for example, where they receive some protection from the weather.

Those species in Class 4 would require preservative treatment for any structural use.

Specific tests to determine fitness for purpose in above-ground situations are:

A deck made of naturally durable *Eucalyptus saligna*.

Fence Battens

Table 3. Fence batten test

Species	Years in test	No. in test	Mean % soundness[1]	(No. failed)	Comment
E. pilularis	26	112	73	1	good condition
E. botryoides	26	98	71	0	fairly good
E. muelleriana	26	96	67	2	fairly good
E. saligna	26	120	64	4	fairly good
E. obliqua	26	117	64	9	fairly good
Macrocarpa	26	99	51	15	fair/poor condition

[1] 100 = perfect condition 0 = failed

The function of a fence batten is to stop wires separating under pressure from stock. Durability and an ability to hold staples are more important than appearance. With the possible exception of macrocarpa, all species tested will perform adequately for at least 25 years in this situation.

Decking

Bare feet are frequently in contact with patio decks, or swimming pool surrounds, therefore resistance to splintering is just as important as durability for decking timbers. Of the species tested, *E. saligna* and *E. botryoides* are marginally superior to the other species as regards durability, but results to date also reveal much variability in species performance; they have the best average durability, but also have a few severely decayed boards. With those bare feet in mind, checking and the potential for splintering are far more frequent in the eucalypts than in macrocarpa.

Table 4. Decking test

Species	Years in test	No. in test	Mean % soundness	(no. failed)	Comment
E. saligna	9-13	54	81		severe decay in a few boards
E. botryoides	9-12	23	78		severe decay in some boards
E. obliqua	9	10	64		extensive surface decay
E. muellerana	9	10	70		minor surface decay
Red beech	9	12	75		minor surface decay
Macrocarpa	9	10	68	1	severe decay in some boards

Weatherboards

Stability (resistance to warping or excessive movement following wetting or drying) is essential for timbers that are to be used as weatherboards. They are seldom exposed to a severe decay hazard, hence less durable but relatively stable species such as Douglas-fir have the potential to perform reasonably well. Surface coatings may have a large influence on performance; a less stable species will warp and twist more readily under a heat-absorbing dark stain finish than under a light coloured paint or stain.

Table 5. Weatherboard test

Species	Years in test	No. in test	Mean % soundness	Comments
E. botryoides /saligna	12	52	90	good condition, some small checks
Macrocarpa	6-9	201	85	fairly good, some small checks
Lusitanica	5	72	85	fairly good, some moderate checks
Redwood	9-17	96	84	moderate weathering
Lawson's cypress	9-13	81	84	fairly good, small checks
Western red cedar	9-17	99	83	fairly good, moderate weathering
Red beech	9	26	79	fairly good, moderate distortion
Hard beech	9	24	79	fairly good, moderate distortion
Douglas-fir	8	33	78	fairly good, moderate checks

This macrocarpa stand may produce naturally durable timber suitable for a number of above-ground uses.

Roofing Shingles

Roofing shingles must obviously be weather-proof. Although presence of severe decay will reduce this property, resistance to splitting is of equal importance.

Of the species tested, lusitanica and *E. saligna* have performed best as shingles, although numerous light surface checks and some distortion have developed in the *E. saligna.* Locally-grown western red cedar and *E. obliqua* contained sufficient decay after 16 years to render them no longer water-proof.

Note that North American grown western red cedar, the "benchmark" as regards suitability for roofing shingles, is by no means immune from decay indefinitely. Our tests have shown that untreated imported western red cedar shingles developed significant decay in 15 years.

Table 6. Roofing shingles test

Species	Years in test	No. in test	Mean % soundness	Comments
Lusitanica	16	30	86	
E. saligna	16	30	70	fair condition
Western red cedar (imported)	17	41	63	poor condition
E. obliqua	16	30	62	poor condition

Conclusions

Totara, silver pine, and red beech are timbers from our native forests which had reputations for high durability long before the advent of preservative-treated pine, which, by necessity, replaced them for constructional use.

While there is some management of red and hard beech plantation forests in Westland, it is largely impractical to consider growing most native species in plantations to provide naturally durable constructional timber, but there are a number of exotic species which could be grown for specific uses. Their in-service performance will not be as predictable as that of preservative-treated pine, and utilisation of some species will be severely limited by properties other than durability. Current problems of plantation management of some species,such as the high susceptibility of *E. saligna* and *E. botryoides* to defoliating insects, poor growth form of Robinia, may seriously limit utilisation potential.

If these problems can be overcome, best options in terms of timber properties seem to be robinia and, to a lesser extent, some of the eucalypts, for in-ground use; macrocarpa and lusitanica for above ground situations where stability and aesthetic qualities are needed; and the eucalypts, saligna and botryoides, for "heavier duty" above ground uses.

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