Theme: Specialty Wood Products (SWP)

Technical Report

Rotary peeling of 15 year old *E. bosistoana* and *E. quadrangulata*

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EXECUTIVE SUMMARY

It was demonstrated that rotary peeled veneers of good surface quality can be obtained from 15 year old *Eucalyptus bosistoana* and *E. quadrangulata* trees grown in New Zealand. The mechanical properties of the *E. bosistoana* veneers (average dynamic MoE 16.6 GPa) and their radial profiles were comparable to the best species (*E. cloeziana* or *Corymbia citriodora*) investigated in Australia from a similar aged resource and outperforming *radiata pine*.

Growth-stresses can cause heart checking and veneer splitting. These were pronounced in veneer from one of the *E. quadrangulata* logs. The *E. bosistoana* veneers did not suffer from veneer splitting.

Because of the limited samples size (3 *E. bosistoana* and 2 *E. quadrangulata* trees) these results are only an indication of the potential of the species. As NZDFI plantations mature, more trees will become available to verify the findings and further consider genetic and environmental effects on the key traits.

The veneers are now available for further research, for example gluing trials.

INTRODUCTION

Opportunities

Eucalypts (NZDFI and others) have potential for use in LVL or plywood. Several opportunities can be seen:

1) High MoE
   Eucalypts (in particular NZDFI species) are very stiff, even at young age.

2) Fibre cost
   Eucalypts grow fast and due to their higher stiffness at young age, they can be peeled to a narrow peeler core (~2 cm) with spindle-less lathes. This could allow the use of small diameter (i.e. young) logs to produce veneer with adequate/good stiffness at a low cost.

3) Natural durability
   NZDFI eucalypts form durable heartwood, which has potential for preservative-free durable/termite resistant products.

Background

Laminated Veneer Lumber (LVL) producers in New Zealand are looking for an alternative fibre supply to radiata. Production of LVL from radiata is currently commercially viable. However, preservatives are required to make the radiata products decay and termite resistant.. Such treated products are perceived negatively in some export markets. More importantly, radiata pine cannot be used to produce high stiffness products, yet the size of timber buildings is increasing dramatically. Large wooden construction places high demands on the stiffness of the utilised timber products. Super-stiff timber products (16 GPa and above) cannot be manufactured economically from radiata pine as it does not form strong enough wood.

Furthermore, radiata pine contains a considerable amount of low-stiffness corewood. This restricts the production of structural grade veneers to the outerwood of the stem. The corewood is rejected in large diameter (~8 cm) peeler cores and used for lower value products such as MDF or firewood. The need for outerwood a) requires the supply of large diameter logs from older trees and b) decreases recovery of structural veneer from these logs. Both effects increase fibre cost. Peeling technology is not constraining the conversion of a larger stem volume to veneer. Spindle-less lathes achieve peeler cores of ~2 cm. Spindle-less lathe technology is now extensively used in China for peeling non-durable sub-tropical eucalypt species (Arnold et al. 2013). Also Australian plywood manufactures have replaced conventional lathes with spindle-less technology. QDAF. Australia, is actively researching and promoting the use of small diameter eucalyptus logs for rotary peeled veneer production (Robert Lee McGavin 2016), reporting that recovery of dry graded and trimmed veneers is around twice as high as sawn timber for such a resource (https://www.fwpa.com.au/forwood-newsletters/1814-tech-enabling-better-land-management-and-extra-revenue-for-private-native-sector.html).

On optimal sites, eucalypts can achieve growth rates exceeding those of radiata pine, while producing stiffer wood. Additionally the wood of some eucalypts can be naturally durable. Therefore, eucalypts are a well suited to supply wood for structural timber products such as LVL or plywood, achieving two different objectives. First, the production of higher value structural products (16 GPa and above) that requires exceptionally stiff veneers could be obtained from some eucalypts in reasonable quantities. Second, if considering standard LVL products (8 to 13 GPa), which are currently manufactured from radiata pine, fibre costs could be reduced by utilising trees grown in shorter rotations and achieving higher veneer yields.

Objectives

1. Demonstrate that quality veneers and LVL can be manufactured from young NZ grown *E. bosistoana* and *E. quadrangulata.*
2. Produce material to conduct gluing studies and produce prototypes.
3. Characterise veneer properties.

METHODS

The logs summarised in Table 1 were delivered to NPI, Richmond on the 27th of November 2018 (Figure 1). Heart checking due to growth stresses developed in particular in log Q2 (Figure 2). Heart checking leads to veneer splitting and reduction in veneer quality and yield. Growth stresses are included in the NZDFI breeding programme and *E. bosistoana* as well as *E. quadrangulata* genotypes with low growth strain have been identified in the just completed MPI SFF407602 (minimising growth strain in eucalypts to transform processing). These are currently propagated as clones from cuttings and available commercially by 2021.

Table 1: Summary of New Zealand-grown logs used for veneer peeling.

Tree number	Tree species	Log number	LED (cm under bark)	SED (cm under bark)
Q1	*E. quadrangulata*	Q1/1	29	24
Q1	*E. quadrangulata*	Q1/2	24	21
Q1	*E. quadrangulata*	Q1/3	21	20
Q2	*E. quadrangulata*	Q2	24	20
B1	*E. bosistoana*	B1	26	20
B2	*E. bosistoana*	B2	27	21
B3	*E. bosistoana*	B3	25	20

Figure 1: Logs before boiling.

Figure 2: log ends after felling showing heart checks but also the heartwood/sapwood boundary.

Logs were peeled at NPI on the 29th of November 2018 after boiling in bark. Veneers were labelled and dried. Unfortunately, the labels were unreadable in the veneer scanner and therefore the data not recoverable.

Dried veneers were transported to the New Zealand School of Forestry, University of Canterbury, where air-dry density and acoustic velocity were measured. Acoustic velocity was measured with the Fakkop time of flight device on the full sheet length at the left, right and centre position in air-dry condition. These three values were then averaged for each veneer sheet. Density was calculated from mass and volume (geometric) measured on defect free samples (~100 mm x 50 mm) cut from each sheet.

Radial position of the individual veneers was estimated by successively adding the appropriate radius for each veneer sheet to the peeler core.

RESULTS

Peeling

The lathe was not able to cut through the bark, resulting in the 1st two logs falling of the lathe, damaging the log ends. Additionally one of these logs (Q2) had significant end splitting (Figure 3). As a consequence not many veneers could be recovered and the peeler cores were substantial (logs Q1/1 and Q2) (Table 2).

Figure 3: Dried veneers and peeler cores from 15 year old E. bosistoana and E. quadrangulata trees grown in New Zealand.

After manual removal of the bark, peeling went smoothly. In total 33 veneers were recovered from the 7 logs, ranging from 1 to 7 veneers per log (Table 2). The quality of the veneer was judged to be good by experienced staff from two NZ veneer producers (Figure 4). To note is the veneer splitting in the sheet obtained from the Q2 log (Figure 4 bottom right), which had developed significant heart checking due to growth stress.

Table 2: Summary of veneers obtained from 15 year old E. bosistoana and E. quadrangulata trees grown in New Zealand.

Species	Tree No	Log No	Veneer No	SED (mm)	Estimated radial position (mm)	Mean Acoustic velocity (Km/s)	Veneer thickness (mm)	Density (kg/m³)	MoE (GPa)
E. bosistoana	1	1	1	200	47.5	4.00	2.98	848	13.5
E. bosistoana	1	1	2	200	60	4.52	2.98	778	15.9
E. bosistoana	1	1	3	200	70	4.75	3.1	780	17.6
E. bosistoana	1	1	4	200	79	4.72	3.05	839	18.7
E. bosistoana	1	1	5	200	87	4.73	3	827	18.5
E. bosistoana	2	1	1	210	47.5	4.07	3.15	769	12.7
E. bosistoana	2	1	2	210	60	4.30	3.06	745	13.8
E. bosistoana	2	1	3	210	70	4.20	3	730	15.2
E. bosistoana	2	1	4	210	79	4.56	2.96	775	18.5
E. bosistoana	2	1	5	210	87	4.88	2.95	818	18.8
E. bosistoana	2	1	6	210	94.5	4.80	2.9	776	13.7
E. bosistoana	3	1	1	200	47.5	3.99	2.9	926	14.7
E. bosistoana	3	1	2	200	60	4.43	3.12	904	17.8
E. bosistoana	3	1	3	200	70	4.47	2.96	969	19.4
E. bosistoana	3	1	4	200	79	4.53	2.95	835	17.2
E. bosistoana	3	1	5	200	87	4.47	3	787	15.7
E. bosistoana	3	1	6	200	94.5	4.81	2.97	792	18.3
E. bosistoana	3	1	7	200	101	4.93	3.15	739	18.0
E. quadrangulata	4	1	1	240	79	4.41	3	657	12.8
E. quadrangulata	4	1	2	240	87	4.59	2.9	715	15.0
E. quadrangulata	4	1	3	240	94.5	4.41	2.85	692	13.5
E. quadrangulata	4	2	1	210	47.5	4.16	2.95	557	9.6
E. quadrangulata	4	2	2	210	60	4.31	2.92	689	12.8
E. quadrangulata	4	2	3	210	70	4.55	2.98	680	14.1
E. quadrangulata	4	2	4	210	79	4.46	2.95	693	13.8
E. quadrangulata	4	2	5	210	87	4.42	2.8	714	14.0
E. quadrangulata	4	2	6	210	94.5	4.21	3	703	12.4
E. quadrangulata	4	3	1	200	47.5	4.23	3.05	623	11.1
E. quadrangulata	4	3	2	200	60	4.27	2.96	632	11.5
E. quadrangulata	4	3	3	200	70	4.47	2.92	669	13.4
E. quadrangulata	4	3	4	200	79	4.57	2.8	753	15.7
E. quadrangulata	4	3	5	200	87	4.60	2.83	789	16.7
E. quadrangulata	5	1	1	200	95	5.12	2.85	682	17.9
Pine	6	1	1	NA	NA	4.53	3.86	456	9.4

Figure 4: Representative veneers of 15 year old E. bosistoana (left) and E. quadrangulata (right) grown in New Zealand.

Veneer properties

E. bosistoana veneers (dry density 813 kg/m^3; MoE 16.6 GPa) were on average denser and stiffer than the veneers obtained from *E. quadrangulata* (dry density 683 kg/m^3; MoE 13.6 GPa) (Figure 5 and Figure 6). The difference in dynamic MoE was largely due to higher density, rather than differences in acoustic velocity. However, it is important to note that these values only represent three *E. bosistoana* and two *E. quadrangulata* trees and were not necessarily a representative sample. Both eucalypts outperformed radiata pine.

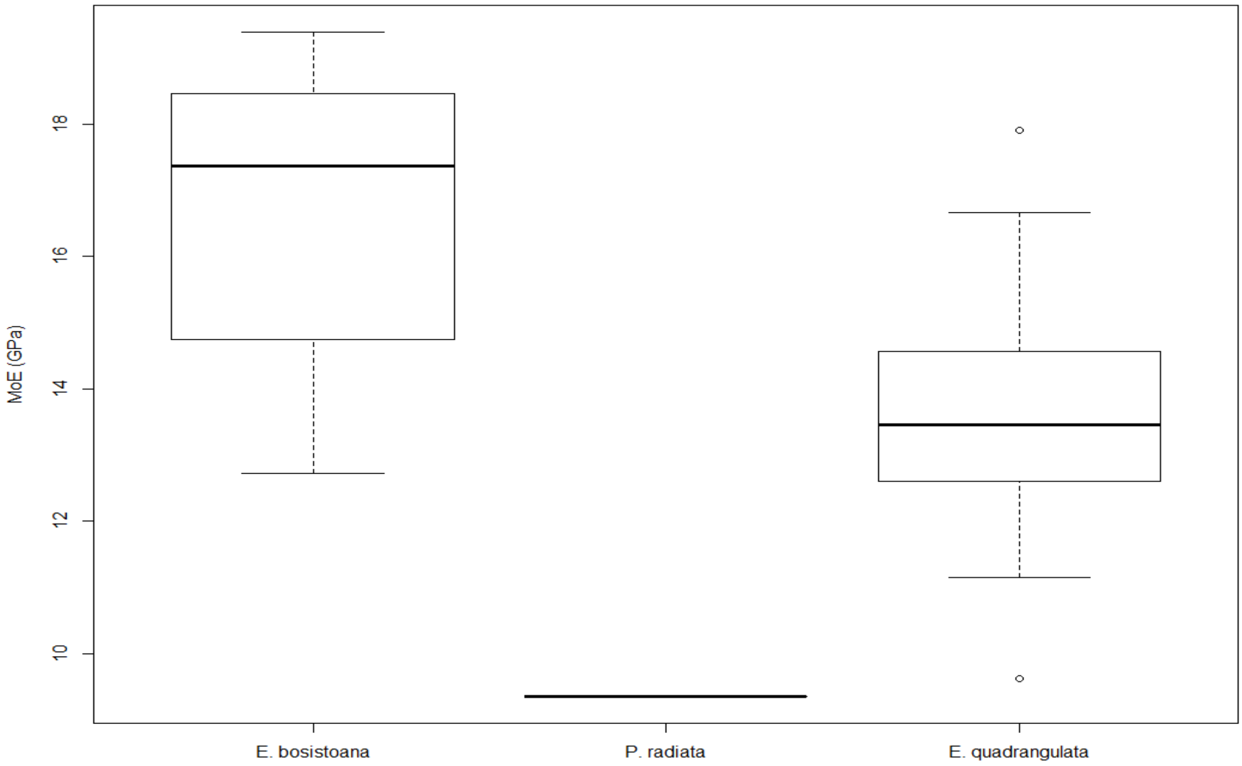

Figure 5: Dynamic MoE of E. bosistoana and E. quadrangulata peeled from 15 year old trees grown in NZ. A random P. radiata veneer sheet is also included. Note: this data comprises only 3 E. bosistoana and 2 E. quadrangulata trees.

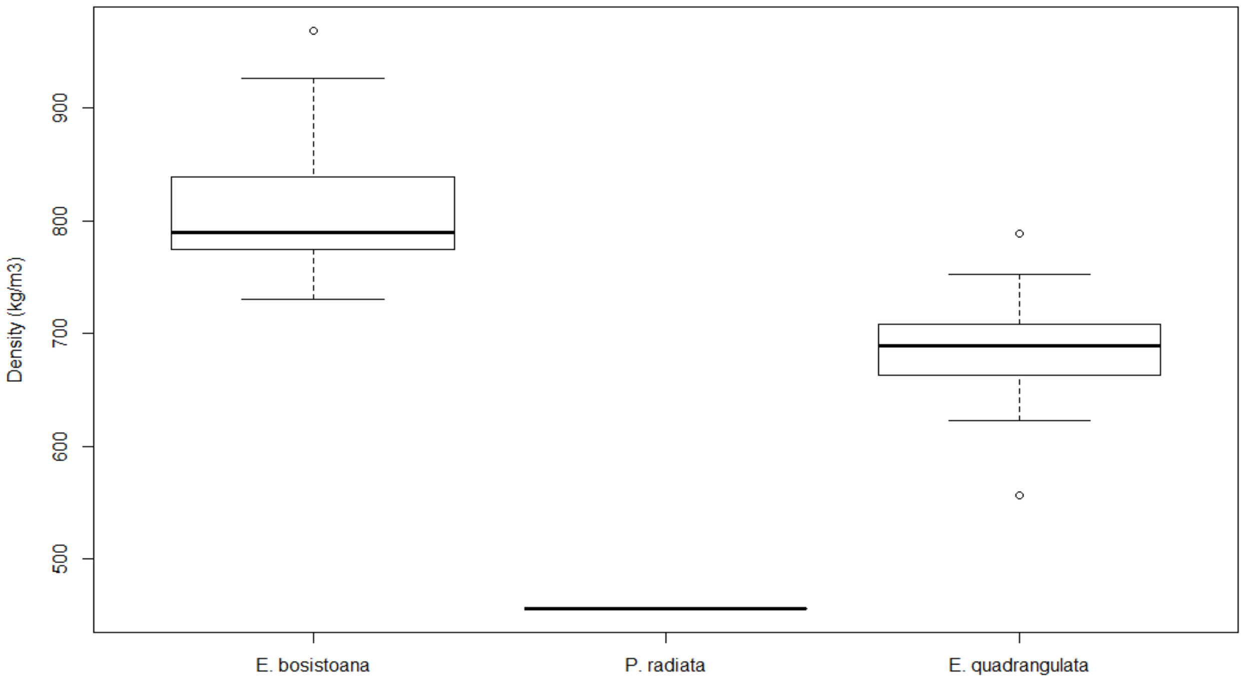

Figure 6 Air-dry density of E. bosistoana and E. quadrangulata peeled from 15 year old trees grown in NZ. A random P. radiata veneer sheet is also included. Note: this data comprises only 3 E. bosistoana and 2 E. quadrangulata trees.

An attempt was made to visualise radial dynamic MoE (Figure 7) and air-dry density (Figure 8) profiles for the logs/species. Again, caution needs to be taken when extrapolating to characterisitcs of the species as the sample was small.
For *E. bosistoana* a radial trend in dynamic MoE but not density seemed to be present. This suggested a radial trend in acoustic velocity, a measure of microfibril angle. Dynamic MoE appeared to be stable from ~65 mm (ie 130 mm diameter) at ~16 GPa. Closer to the pith (at 45 mm radius) dynamic MoE was ~14 GPa, comparing favourably with *P. radiata* outerwood. Screening the NZDFI *E. bosistoana* breeding population revealed a dynamic MoE of ~11 GPa at the base of 2 year old trees, providing a lower bound for the species (SFF407602). The maximum veneer stiffiness for these three 15 year old trees was 19.4 GPa, indicating that genetically improved and/or older trees could yield high stiffness veneers.
In contrast to *E. bosistoana*, air-dry density of *E. quadrangulata* increased radially for the 15 year old tree. This coincided with a radial increase in dynamic MoE. *E. quadrangulata* was, less stiff with a maximum dynamic MoE of 17.9 GPa fro a veneer. However, at age 2 years old the avarage MoE of the NZDFI *E. quadrangulata* breeding population was ~12 GPa (SFF407602), about the same as at 50 mm radius in the peeled tree.

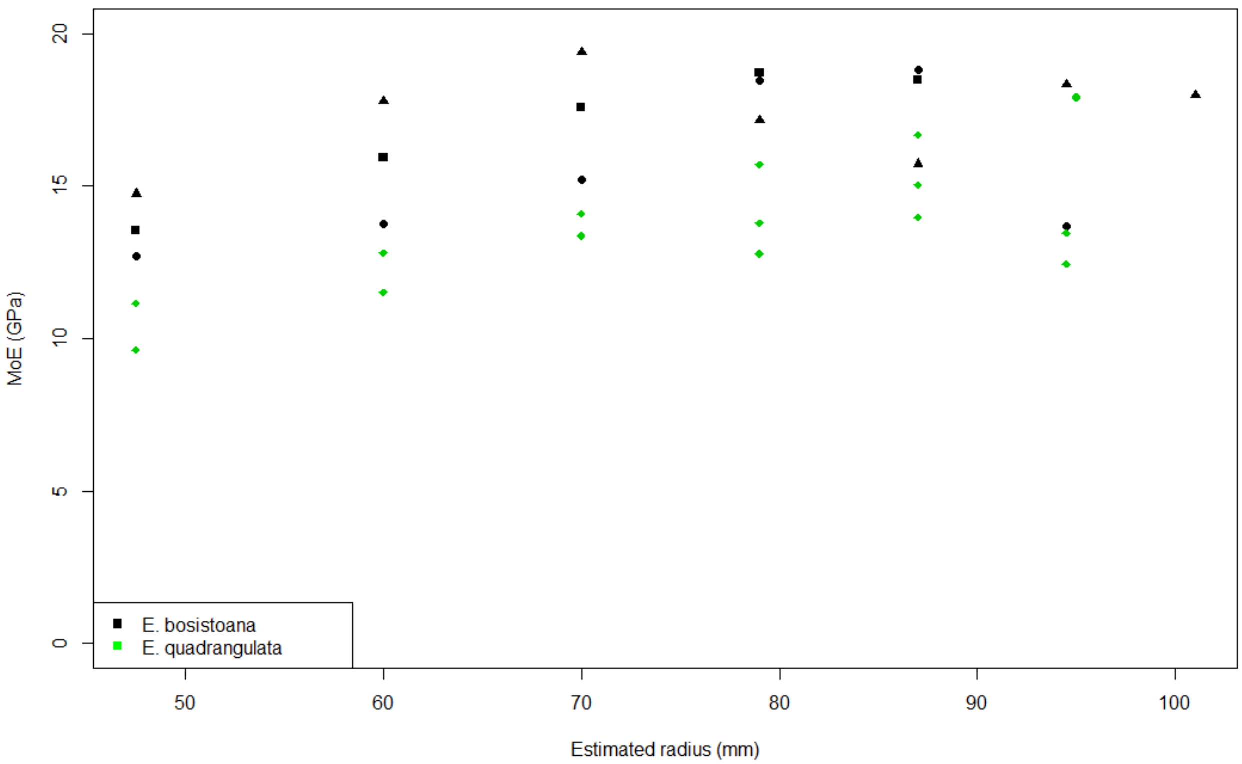

Figure 7: Radial dynamic MoE profile of E. bosistoana (black) and E. quadrangulata (green) veneers peeled from 15 year old trees grown in NZ. Symbols encode individual trees.

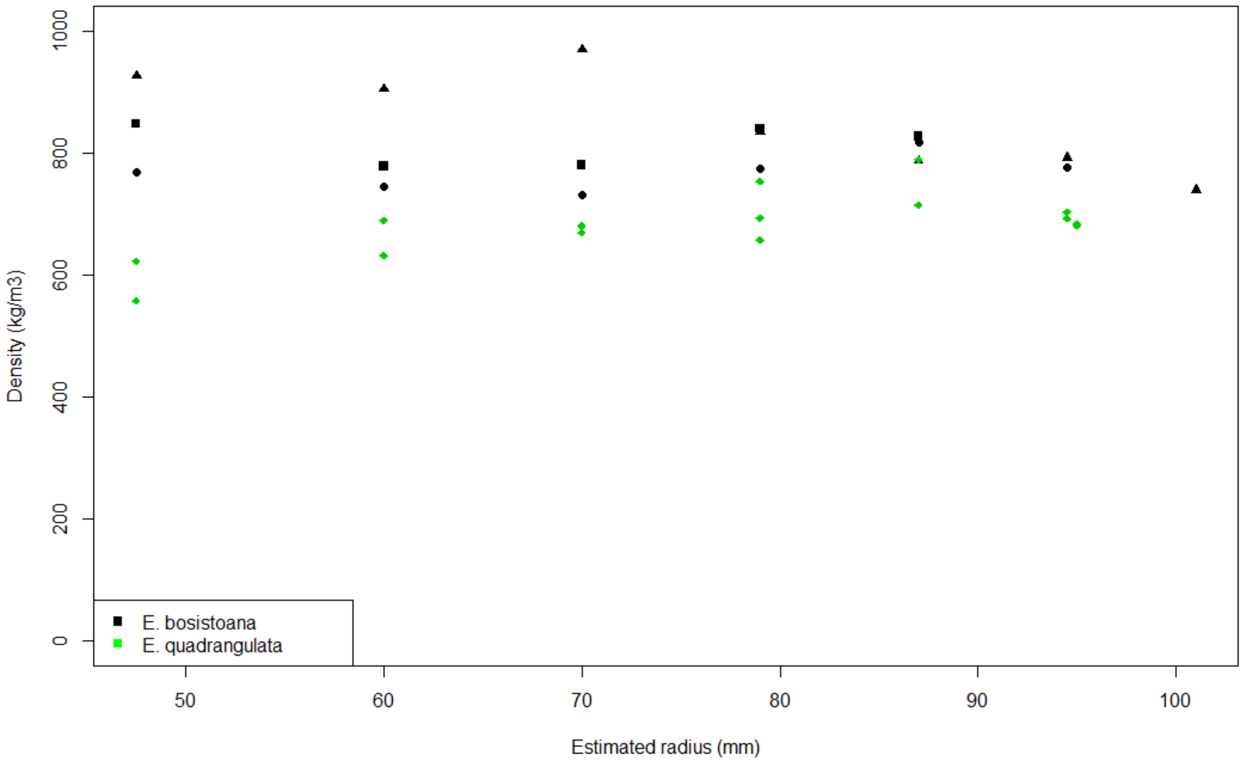

Figure 8: Radial air-dry density profile of E. bosistoana (black) and E. quadrangulata (green) veneers peeled from 15 year old trees grown in NZ. Symbols encode individual trees.

Context

Logs from nine New Zealand grown 30 year old *E. globoidea* trees have been peeled previously (Guo & Altaner 2018) (Figure 9). At twice the age, the average dynamic MoE (15.1 GPa) was lower than the values for the *E. bosistoana* (16.6 GPa) but higher than those for the *E. quadrangulata* (13.6 GPa) veneers assessed in this study. The mean dry density of *E. globoidea* (688 kg/m^3) was comparable to that of the *E. quadrangualata* (683 kg/m^3) and lower than for *E. bosistoana* (813 kg/m^3).

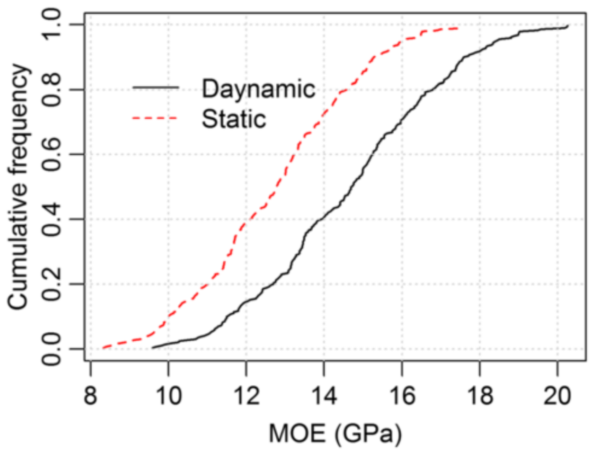

Figure 9: Cumulative distribution of dynamic and static MoE of veneer sheets. From (Guo & Altaner 2018).

The mean dynamic MoE values also fell within the range reported for rotary peeled veneers form a young (10 to 22 year old) plantation grown eucalypts resource (12.3 to 16.2 GPa) (McGavin et al. 2015). Also the radial trends are comparable (Figure 10). The larger sample size of the Australian study showed a large variation in veneer stiffness, with veneers exceeding 20 GPa (Figure 11).

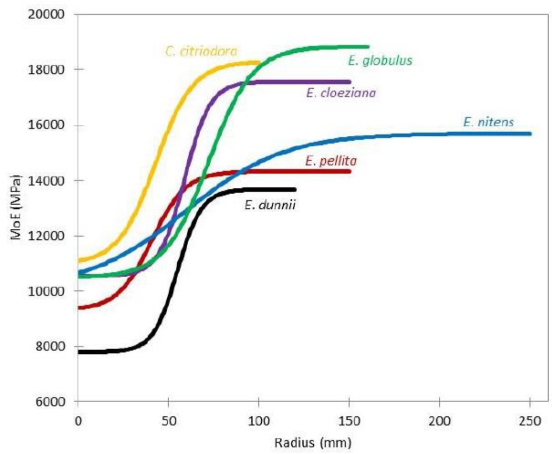

Figure 10: Fitted MoE sigmoid curves across the radius for the six trialled species. From (McGavin et al. 2015).

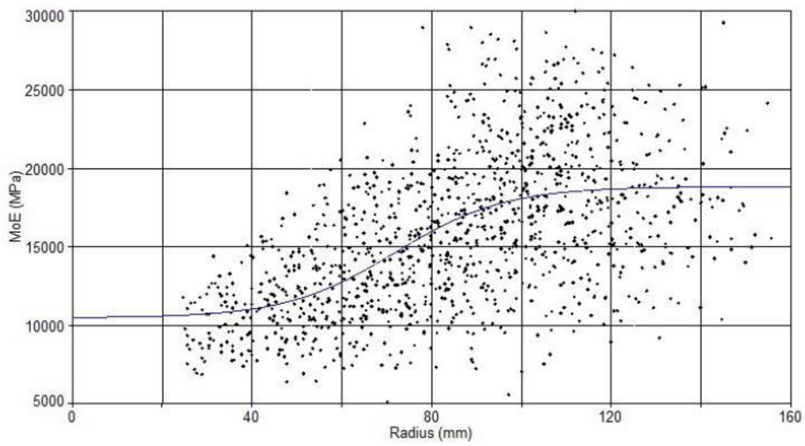

Figure 11: Eucalyptus globulus modelled sigmoid curve for MoE across the radius and actual measured vales. From (McGavin et al. 2015).

The stiffness of the veneers from the 15 year old New Zealand grown *E. bosistoana* trees also compared favourably with that for same aged New Zealand grown *E. nitens* (Gaunt et al. 2003) (Figure 12).

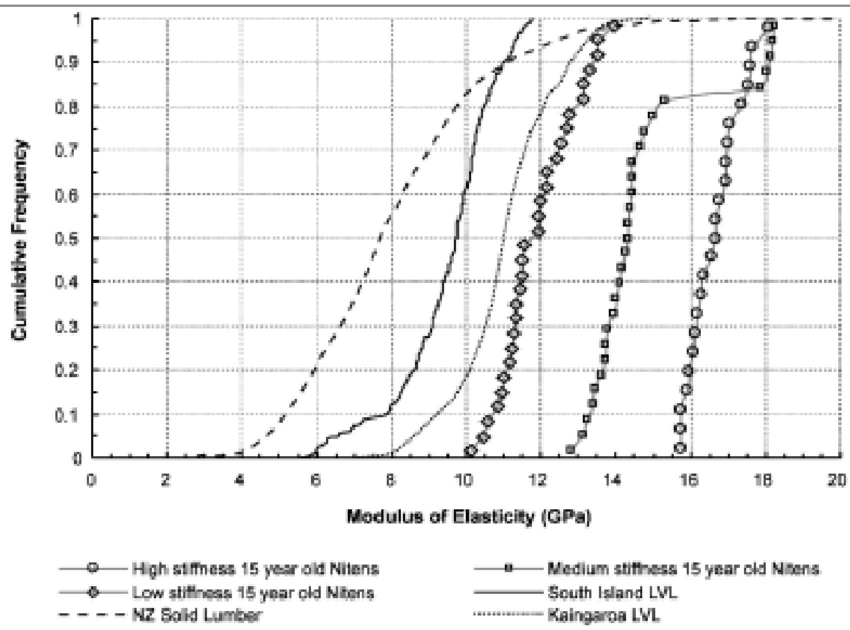

Figure 12: Modulus of Elasticity comparison. From (Gaunt et al. 2003).

ACKNOWLEDGEMENTS

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REFERENCES

Arnold, R.J., Xie, Y.J., Midgley, S.J., Lou, J.Z., & Chen, X.F. (2013). Emergence and rise of eucalypt veneer production in China. *International Forestry Review, 15*(1), 33-47.

Gaunt, D., Penellum, B., & McKenzie, H.M. (2003). Eucalyptus nitens laminated veneer lumber structural properties. *New Zealand Journal of Forestry Science, 33*(1), 114-125.

Guo, F., & Altaner, C.M. (2018). Properties of rotary peeled veneer and laminated veneer lumber (LVL) from New Zealand grown Eucalyptus globoidea. *New Zealand Journal of Forestry Science, 48*(1), 3. doi: 10.1186/s40490-018-0109-7

McGavin, R.L. (2016). *Analysis of small-log processing to achieve structural veneer from juvenile hardwood plantations.* Retrieved from http://hdl.handle.net/11343/59117

McGavin, R.L., Bailleres, H., Fehrmann, J., & Ozarska, B. (2015). Stiffness and Density Analysis of Rotary Veneer Recovered from Six Species of Australian Plantation Hardwoods. *BioResources, 10*(4), 6395-6416.