# Research note

# Identifying check-prone trees of *Eucalyptus globulus* Labill. using collapse and shrinkage measurements

Jun-Li Yang[1] and David Fife[2]

[1]CSIRO Forestry and Forest Products, Private Bag 10, Clayton South, Vic 3169, Australia
Email: junli.yang@csiro.au
[2]CSIRO Forestry and Forest Products, Airport Road, Mt Gambier, SA 5290, Australia

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## Summary

Fifty-nine trees were sampled from three provenances of 10-y-old *Eucalyptus globulus* Labill. plantations grown at two sites in South Australia. The butt logs were backsawn and 176 boards (40 mm × 100 mm × 3600 mm) from the centre cant (two to four boards per cant) were dried. A 10-mm-thick cross-section was removed 400 mm from the end of each board (corresponding to the smaller end of the log) and inspected for the presence of internal checks. The samples were ranked using the mean values of several wood properties, including tangential collapse, total tangential shrinkage, density, growth strain, microfibril angle (MFA) and cellulose crystallite width ($W_{cryst}$). The rank positions of the check-prone trees were inspected in each ranking. Tangential collapse showed good potential for identifying the check-prone trees, while total tangential shrinkage and total cross-sectional shrinkage were slightly less sensitive. Density, growth strain, MFA, $W_{cryst}$ and other shrinkage properties were not as useful. It is recommended that tree breeders should use total tangential shrinkage as an indicator to identify check-prone trees, because this property is not only reliable but can be easily measured on trimmed increment cores at low cost.

*Keywords*: collapse (drying); shrinkage; checks; drying; wood defects; *Eucalyptus globulus*

## Introduction

Internal checking and surface checking severely affect the recovery of high-value sawn timber products. Such checking is the most serious form of drying degrade in the Australian hardwood timber industry. Internal checking is often associated with cell collapse during drying and is common in many pale-coloured eucalypt species (Bisset and Ellwood 1951; Kauman 1960, 1964; Pankevicius 1962; Cuevas 1969; Chafe 1985; Ilic and Hillis 1986; Wilkes 1988; Thomson 1989; Bekele 1995; Innes 1996; Yang and Waugh 1996a,b; Ilic 1999a). The severity of internal checking generally increases with collapse (Innes 1996; Ilic 1999a). In studies on regrowth *E. regnans* (Ilic 1999a), collapse alone accounted for 47% of the total variation in internal checking on a board basis.

This paper reports the potential for using various wood properties to identify trees that are prone to develop internal checking during drying. The investigation is part of a comprehensive study on 10-y-old plantation-grown *Eucalyptus globulus* Labill. completed recently at CSIRO. In that project, major wood properties were determined including density, growth strain, shrinkage properties, microfibril angle (MFA) and cellulose crystallite width ($W_{cryst}$). Relationships between those properties and between-provenance and between-site variation were examined, and their effects on the quality of sawn timber were investigated. For the results of growth strain assessment, see Yang and Fife (2000) and Yang *et al*. (2001); for the effect of growth strain and log defects on the quality of sawn timber, see Yang *et al*. (2002a); for shrinkage properties, see Yang *et al*. (2002b); for relationships of shrinkage properties with microfibril angle and cellulose crystallite width, see Yang *et al*. (2003).

In this report, ‘shrinkage property’ is used as a general term to refer to linear shrinkage properties (shrinkage, collapse and total shrinkage in radial and tangential directions) and cross-sectional shrinkage properties (cross-sectional shrinkage and total cross-sectional shrinkage).

## Materials and methods

Fifty-nine trees were sampled from three provenances (Jeeralang, King Island and South-eastern Tasmania) of 10-y-old *E. globulus* Labill. plantations grown at two sites (Heath Block and Johnstons Block) near Mt Gambier, South Australia. Descriptions of the sites and the sample trees are given in Tables 1 and 2.

Growth strain was measured on the surface of each sample tree at breast height, and on the surface of the first bushlog at heights of 2.5 m, 4.3 m and 6.1 m after felling and debarking. There were three equi-spaced measurements at each height. Mean growth strain was calculated for each height of each tree and for each sawlog. From each first bushlog, one billet 1.2 m long was removed from the larger log end, followed by a sawlog 3.6 m long.

**Table 1.** Growth characteristics of trees within the measurement plot of each provenance at each site

| Tree properties | Heath Block | | | Johnstons Block | | |
|---|---|---|---|---|---|---|
| | Jeeralang | King Is. | SE Tas | Jeeralang | King Is. | SE Tas |
| Stocking (stems ha$^{-1}$) | 833 | 1042 | 917 | 958 | 875 | 458 |
| Mean DBHOB (mm) | 175 | 217 | 182 | 232 | 216 | 257 |
| SD of DBHOB (mm) | 86 | 50 | 81 | 52 | 70 | 67 |
| Basal area (m$^2$ ha$^{-1}$) | 24.6 | 40.6 | 28.3 | 42.3 | 35.2 | 25.2 |
| MAI (m$^3$ ha$^{-1}$) | 21 | 41 | 23 | 37 | 27 | 21 |

**Table 2.** Mean values of measured growth characteristics of the harvested trees

| Tree properties | Heath Block | | | Johnstons Block | | |
|---|---|---|---|---|---|---|
| | Jeeralang | King Is. | SE Tas | Jeeralang | King Is. | SE Tas |
| DBHOB (mm) | 279 | 265 | 265 | 290 | 282 | 287 |
| Tree height (m) | 25.1 | 30.0 | 24.6 | 26.6 | 22.8 | 24.9 |
| Height at low crown (m) | 12.0 | 17.6 | 13.4 | 12.0 | 11.8 | 13.4 |
| Diameter at low crown (mm) | 161 | 152 | 144 | 184 | 164 | 172 |
| Volume of tree stem (m$^3$) | 0.524 | 0.476 | 0.458 | 0.574 | 0.564 | 0.568 |

The sawlogs were backsawn. Boards from the centre cant (40 mm × 100 mm × 3600 mm) were stacked under weight and air-dried in a warehouse, followed by final kiln drying. After final drying, the boards were dressed to 35 mm × 90 mm in cross-section. One cross-section, 10 mm thick, was removed at 400 mm from the end of each dried board (corresponding to the smaller end of the log) and inspected for internal checking.

From each 1.2 m billet, as many 20 mm × 20 mm × 90 mm (radial × tangential × longitudinal) specimens as possible were prepared along the full diameter. On each specimen, the following wood properties were determined: moisture content (MC), density at 12% MC, radial and tangential shrinkage, radial and tangential collapse, total radial and tangential shrinkage, and total cross-sectional shrinkage. Details of these measurements and calculations are given in Yang *et al*. (2002a). An unweighted average of each of these properties was calculated for each tree.

One SilviScan specimen, with final dimensions 2 mm × 6 mm (tangential × longitudinal) at 12% MC, was prepared along the pre-specified full radius of each billet. Each specimen was scanned using SilviScan, and the MFA and $W_{cryst}$ were simultaneously obtained in one run. For each of MFA and $W_{cryst}$, the data were integrated over 5 mm intervals to produce the average values in each 5-mm radial segment of the specimen. An unweighted average of MFA and $W_{cryst}$ was calculated for each tree.

## Results and discussion

Twelve of the 176 boards showed internal checks, mostly as hairline cracks. These internally checked boards were from nine trees grown at Johnstons Block, almost one board per tree. Trees from all three provenances were affected. Interestingly, not all the boards from these nine trees showed internal checking.

Is there potential for using wood properties to identify trees that have internal checking in sawn boards? To investigate this question, the tree means of all the wood properties mentioned in the above section were ranked in ascending or descending order; then the rankings were inspected to see where the check-prone trees were located.

There was a conspicuous and definite pattern when tangential collapse was used to rank the 59 trees — the nine check-prone trees were all located within the top 50% (Fig. 1). The highest-ranked check-prone tree had the highest mean tangential collapse (12.4%). The lowest-ranked check-prone tree (ranked 21) had tangential collapse of 5.0% (Fig. 1). Trees that had internally-checked boards apparently had higher tangential collapse although not all trees showing higher tangential collapse had internally-checked boards.

Total tangential shrinkage and total cross-sectional shrinkage were less sensitive (Fig. 1). The nine check-prone trees were all within the top 50% when total tangential shrinkage was used to rank the 59 trees, and for total cross-sectional shrinkage the nine check-prone trees were all within the top 60% of the rank. The lowest-ranked check-prone tree had a total tangential shrinkage of 10.5% (ranked 25th) and a total cross-sectional shrinkage of 12.6% (ranked 35th, Fig. 1).

The check-prone trees were scattered over the entire range of the rank and showed no distinct ‘regional’ concentration when density, MC, growth strain at various heights, growth strain of sawlogs, MFA, $W_{cryst}$ and the rest of the shrinkage properties were used to rank the 59 trees.

In summary, tangential collapse showed good potential — better than that of any other wood property in terms of accuracy — to identify trees that had internally-checked boards. The second and

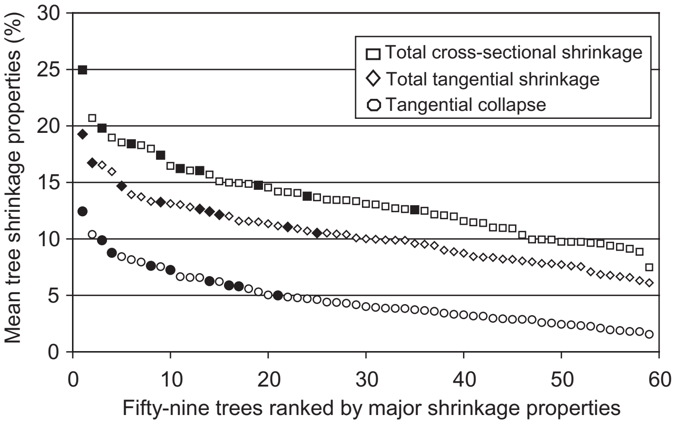

**Figure 1**. Ranking of 59 trees by the tree means of tangential collapse, total tangential shrinkage and total cross-sectional shrinkage at breast height, respectively. The solid data points represent check-prone trees.

third best indicators were total tangential shrinkage and total cross-sectional shrinkage. Density, MC, growth strain, MFA, $W_{cryst}$ and other shrinkage properties showed little prospect in this regard.

From a practical point of view, however, total tangential shrinkage is a more suitable property than tangential collapse for this identification or prediction purpose because only one drying step is required. Total tangential shrinkage is not only a good identifier but also can be easily measured from trimmed increment cores at low cost. It is easier to measure than tangential collapse because re-conditioning and post equilibration are not required. The potential of this method is supported by earlier findings that collapse of rapidly-dried small end sections of regrowth *E. regnans* was a good predictor of internal checking in boards (Ilic 1999a,b). The method should also apply to trees that contain tension wood.

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