

# Predicting performance of sawn boards by using transverse cores of standing trees

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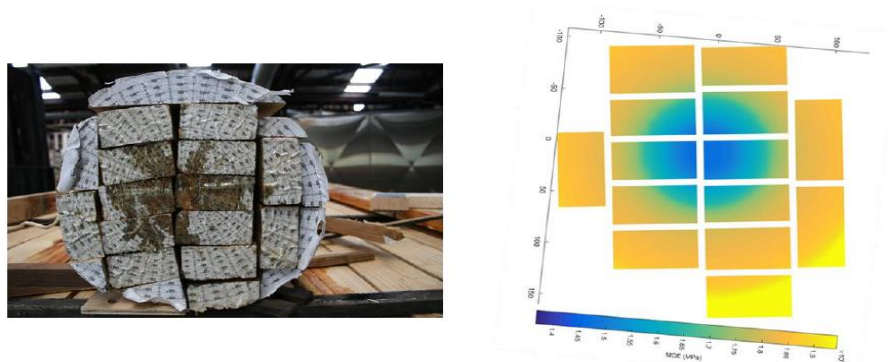
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## ABSTRACT

The accurate assessment of the mechanical properties of timber from standing trees is beneficial for the growers and processors. Modulus of elasticity (MOE) is one of the most important mechanical properties for solid timber which determines the structural performance and market value of a sawn piece timber. MOE of boards sawn from a single log can vary significantly because of significant internal variation of MOE within a tree. Several techniques are available to evaluate log MOE and MOE of a clear piece of wood. However, the enormous variation of MOE of boards cut from a single log limits the usefulness of an overall log MOE value and establishes the necessity of predicting MOE of individual board.

Therefore, this article aims to predict the MOE of individual sawn boards from measurements taken from transverse cores of standing trees. A total of 68 trees of 19, 24 and 28 years of age and stocking rate of 200 to 2660 stem per hectare were sawn according to industrial sawing pattern to validate the study. The predicted MOE of 625 boards were compared with standard static bending tests following Australian Standard AS/NZS 4063.1:2010.

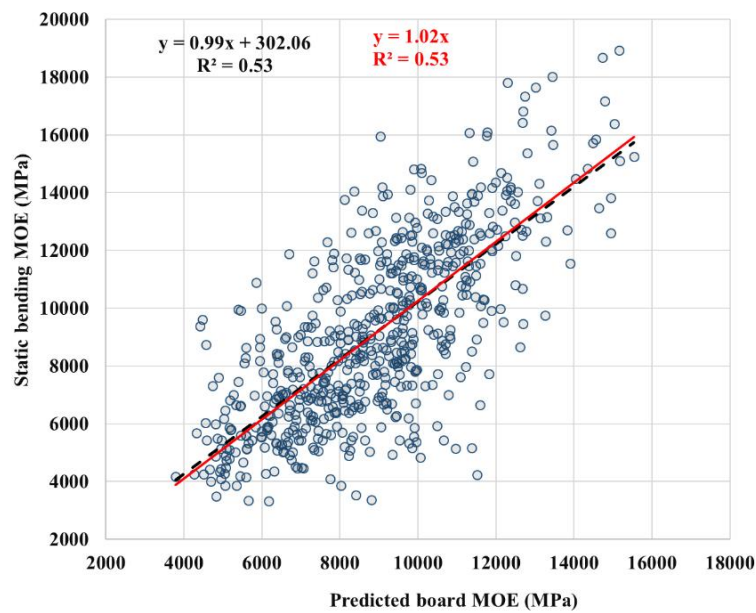
Transverse cores were extracted using a patented tree corer and then the cores were marked out at 20 mm intervals starting at the outer end (bark side). The location of annuals rings, piths and segments were mapped onto a tracing paper. The cores were segmented into 20 mm sections using guillotine and MOE measurements were conducted on these segments using an ultrasound device. The distances of segments from piths were extracted using image analysis in MATLAB to provide MOE variation along the radius of the log. An asymmetric five-parameter logistic (5PL) function was fitted to express MOE as a function of radius of the tree. Virtual boards were cut according to specified sawing pattern used by industry as shown in Figure 1.



**Figure 1.** Actual sawn boards (left) and virtual sawn boards (right)

The virtual boards are then discretized to create control area in 2D and node is created at the center of each control area. Then the MOE of each node is calculated using the 5PL function. Finally, the average MOE of the board were calculated using weighted average MOE of each control area.

Figure 2 illustrates the correlation between the predicted board MOE and static bending MOE of 625 individual boards obtained from the 68 destructively sampled trees. A good correlation was obtained ( $R^2=0.53$ ) considering the fact that the static bending test results can be affected by the knots and defects present in the board. Moreover, some errors could be due to the inaccurate location mapping of sawing pattern of the boards. Remarkably, the correlation displays only marginal bias, i.e. the predicted MOE is directly proportional to static bending MOE as the slope of the regression line is 1.02.



**Figure 2.** Correlation between measured and predicted MOE for 625 boards sawn from 68 trees.

This method provides a simple and accurate approach to predict individual board MOE values obtained from each log. The prediction capacity can be improved by using 3D virtual reconstruction approach and simulating the four-point bending test. The 5PL function fitted between MOE and radius can also be used to estimate the quantity of wood of a specific quality that is available in a log. The board MOE prediction method described in this article can be combined with other techniques to predict MOE of all boards that can be processed from a whole stand from measurements taken from cores of some sampled trees.

**Keywords:** Board MOE, Forest value, Modeling, Prediction, Virtual reconstruction

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