Prediction of tensile strength in sawn timber by means of surface laser scanning and dynamic excitation

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Machine strength grading of sawn timber is based on the relationship between so-called *indicating properties* (IPs) and *grade determining properties* (GDPs). The former are calculated using board properties measured non-destructively whereas the latter are determined by destructive tests. For T-classes, which are used for glulam lamellae, the GDPs are tensile strength ($f_{t,0}$), *modulus of elasticity* (MOE) in tension and density.

The aims of this study were to develop an IP, similar to the one given in [1], for prediction of tensile strength and to calculate yield in different T-classes using this IP. Non-destructive and destructive measurements were made on a total number of 967 boards of Norway spruce with varying dimensions originating from Finland, Norway and Sweden. The non-destructive measurements included in this study were surface laser scanning, X-ray scanning and dynamic excitation, and were carried out both before and after planing of the boards. Results from X-ray scanning were used to calculated board density whereas surface laser scanning and dynamic excitation were used to determine in-plane fibre directions at longitudinal surfaces and axial resonance frequency, respectively. The destructive tests were made after planing.

The IP used for prediction of $f_{t,0}$, herein denoted $IP_{E,b}$, was based on a local MOE calculated by means of observed fibre directions and dynamic MOE (E_{dyn}). Coefficients of determination between $f_{t,0}$ and $IP_{E,b}$ of 0.65 and 0.66 (linear regression) were obtained using measurement results before and after planing, respectively, see Figures 1a and 1b. Applying E_{dyn}, which is used by several grading machine as IP for prediction of $f_{t,0}$, resulted in a coefficient of determination (r^2) of 0.46 for $f_{t,0}$, both before and after planing.

Table 1 gives calculated yield in three different strength classes using the suggested grading method applying $IP_{E,b}$ for prediction of $f_{t,0}$. This table also includes the calculated yield for a grading machine applying E_{dyn} for prediction of $f_{t,0}$. The yield obtained using $IP_{E,b}$ rather than E_{dyn} for prediction of $f_{t,0}$ is much higher, particularly for high strength classes.

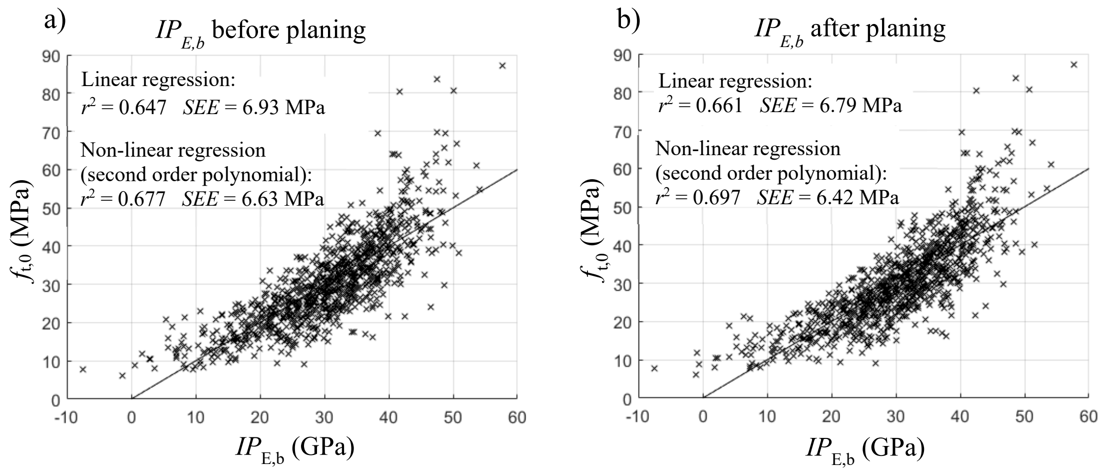

Figure 1: Scatters between $f_{t,0}$ and $IP_{E,b}$. Included in each scatter are r^2 and *standard error of estimate* (SEE).

Table 1 : Yield in strength classes (single grade).

Grade	Suggested grading method (before planing)	Suggested grading method (after planing)	Grading method applying dynamic MOE for prediction of strength
T15	95.3 %	96.3 %	95.5 %
T22	60.9 %	59.0 %	42.9 %
T26	33.4 %	33.5 %	15.9 %

References

[1] A. Olsson, J. Oscarsson, E. Serrano, B. Källsner, M. Johansson & B. Enquist: Prediction of timber bending strength and in-member cross-sectional stiffness variation on the basis of local wood fibre orientation. *European Journal of Wood and Wood Products*, 71 (2013), 319-333.

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