

Off-line timber sorting with portable NIR spectrometer—feasibility study for glulam production

Jakub Sandak^{1,2*}, Peter Niemz^{3,4}, Anna Sandak^{1,5}

¹ InnoRenew CoE, Livade 6, 6310 Izola, Slovenia, jakub.sandak@innorenew.eu

² University of Primorska, Andrej Marušič Institute, jakub.sandak@upr.si

³ ETH, Department of Civil, Environmental and Geomatic Engineering, Zürich, Switzerland

⁴ Berner Fachhochschule, Architecture, Wood and Civil Engineering, Bereich FDW, Solothurnstrasse 102, 2504 Biel, Switzerland, peter.niemz@bfh.ch

⁵ University of Primorska, Faculty of Mathematics, Natural Sciences and Information Technologies, Glagoljaška 8, 6000 Koper, Slovenia, anna.sandak@famnit.upr.si

*Corresponding author

Glulam consists of individual laminates of structural timber, providing highly effective utilization of the raw material. Glulam, with at least four laminates, that has been manufactured, controlled, and marked according to certain rules is graded in strength classes. The appropriate class is determined by the strength of the timber used and its position in the cross-section. Glulam performance is related to material properties (e.g., wood species, density, presence of extractives, defects, different moisture content in the lamellas, or different thickness of the lamellas causing inner stresses), adhesive properties (low quality), or incorrect application (pressure, curing time, use of primers) (Vanya, 2012). The goal of this research was to investigate feasibility of off-line NIR spectroscopy for assurance of glued wood quality.

MicroNIR OnSite-W spectrometer produced by VIAVI Solutions Inc. was manually operated with MicroNIR™ Pro v3.0 software provided by the sensor producer. Spectra were collected from the surface of two wood species: ash (*Fraxinus excelsior*) and beech (*Fagus sylvatica*). PLS_Toolbox (Eigenvector Research, Inc.) and MATLAB R2018b (MathWorks, Inc.) were used for chemometric model development. Extended multiplicative scatter correction (EMSC), standard normal variate (SNV), Savitzky–Golay 1st and 2nd derivatives, and vector normalization were used as alternative spectra preprocessing routines. Principal components analysis (PCA) was applied for explorative analysis of spectra and identification of all outliers or wrongly measured spectra. Partial least squares algorithm was implemented for estimation of wood density, dynamic modulus of elasticity (MoE), wood moisture content, and delamination index (determined as a single value for each replica consisting of six specimens glued together). The best performance was in assessing wood moisture content, with slightly weaker capacity to estimate wood density and mechanical properties. The scanning frequency of the MicroNIR sensor is relatively low (0.5 Hz), allowing off-line scanning; however, the possibility for quality assessment in-line might be problematic.

Keywords: portable NIR, glulam, quality control, off-line sorting

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REFERENCES

Vanya, C (2012) Damage problems in glued laminated timber. *Drewno*, 55, 188, 115-128.