Moisture Content influence on Acoustic Emission Parameters in a drying Scots Pine Log

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Foreword

Indoor climate and its fluctuations play a key role in the conservation of artworks, especially organic and hygroscopic material as wood. This issue is particular sensitive in Norway where valuable wooden historical churches (Stave churches) are endangered from both indoor and outdoor climate [1].

Aim

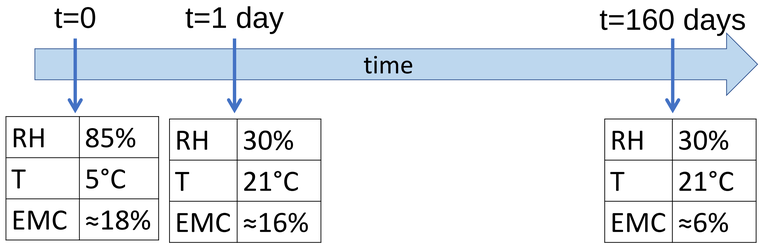
To investigate the effect of indoor climate on the mechanical properties of Scots Pine

Methods

Universal Testing Machine (UTM), Acustic Emission (AE) [3] and Digital Image Correlation (DIC) techniques were used to:

- Investigate on a model describing the penetration of the moisture content level into the wooden beam (Figure 1 and Figure 2)
- Define a relationship between AE parameters and Equilibrium Moisture Content (EMC) after brittle fracture.

Acclimatization of a Scots pine log



EMC calculation [2]: $$RH_{response,i} = \frac{RH_{response,\,i-1} + \frac{RH_i}{n/3}}{1 + \frac{1}{n/3}}$$

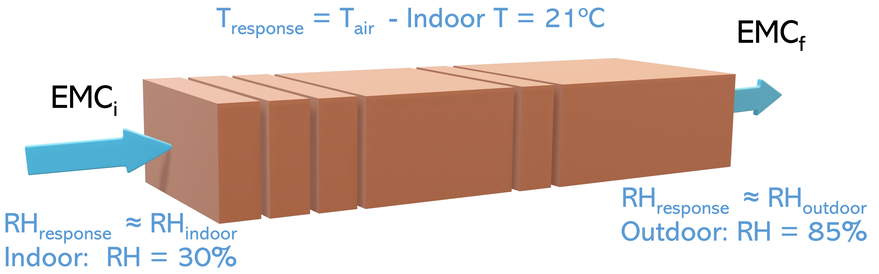


Figure 1: Scots Pine beam reconstruction and its EMC changing from the external slices to the internal ones

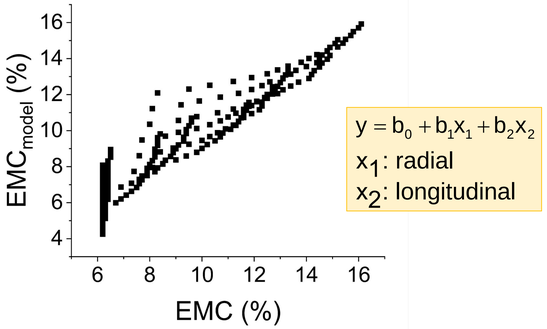


Figure 2: multilinear regression model for EMC

Energy density

The Dinamic Surface Energy Value (DSV), or Energy Density, is the ratio between the Energy released by the AE and the fractured area.

$$DSV = \frac{\Sigma \Delta E}{\Sigma \Delta A_f}$$

Relationship between DSV and EMC

Figure 3 demonstrates that: $EMC = a(DSV)^b$

DSV is a «risk assessment parameter»: when DSV has low values, materials have already acclimatized with the surrounding environment and they are not at risk.

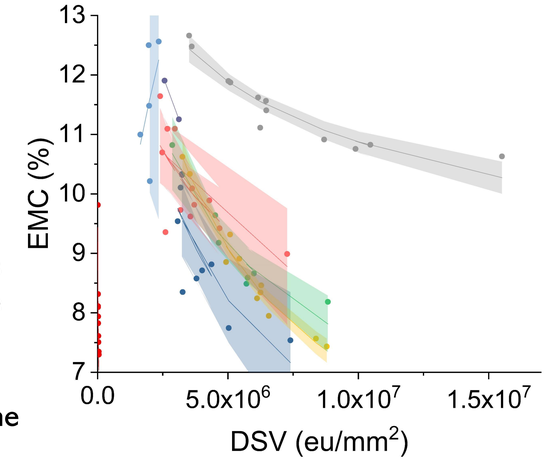


Figure 3: EMC (%) *vs* DSV (eu/mm^2) relationship

Conclusions

- 3 different techniques (UTM, AE and DIC) have allowed to estimate the energy density (DSV) released during natural drying process;
- The EMC has been assessed looking at the beam geometry and at its response time during the drying process;
- EMC *vs* DSV relationship highlights that AE technique can detect the conservation status of a material.

References

[1] C. Bertolin, L. d. Ferri and F. Berto, "Calibration Method for Monitoring Hygro-Mechanical Reactions of Pine and Oak Wood by Acoustic Emission Nondestructive Testing," Materials, vol. 13, no. 17, pp. 1-21, 2020. [2] M.H.J. Martens, Climate risk assessment in museum, Eindhoven University of Technology, 2012. [3] M. Łukomski, Ł. Bratasz, E. Hagan, M. Strojecki and V. L. Beltran, Acoustic Emission Monitoring for Cultural Heritage - Guidelines, Los Angeles: The Getty Conservation Institute, 2020.

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