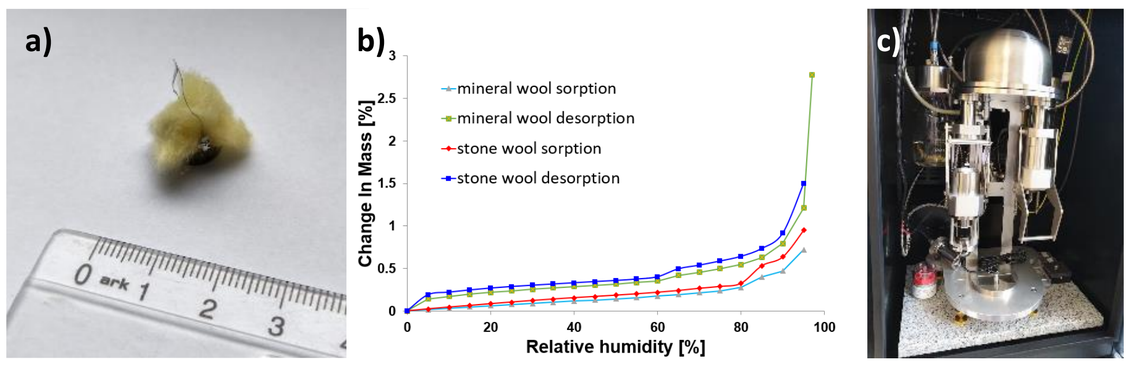
Three Years of Experimental Module woodenHAT

Richard Slávik, Mojtaba Hassan Vand and Dimitrios Tsalagkas
Mendel University in Brno, Faculty of Forestry and Wood Technology, Department of wood science and technology
e-mail: richard.slavik@menelu.cz

Hygrothermal performance of building components is an essential part of integrated building design. Thanks to the energy crisis, we try to design more and more sustainable and nearly zero-energy buildings. Wood and wooden-based materials are susceptible to moisture, so they need a careful and safe design. Just a simplified approach is not enough, thus we need more advanced methods in energy performance as well as in moisture design [1].

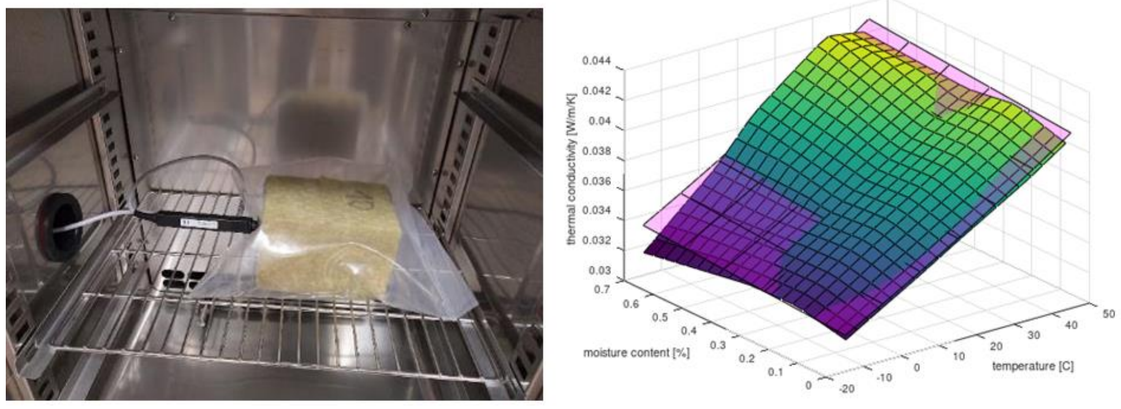
Our project follows contemporary trends in timber components from a building point of view. Within this 3-years project it was developed a testing module with real behavioural data supported with laboratory testing and theoretical work. The last part of the project was focused on the numerical modelling of test components and comparison of measured data with results of numerical model. The main idea is a usage and verification of the numerical algorithms for modelling heat and moisture transport.

Advanced algorithms lack information about sorption behavior of materials, and the influence of transport parameters on temperature and moisture. Some characteristics of common materials could be found in databases. Not all materials are available or similar like materials included in catalogues. Materials with significant influence on the model should be selected very carefully or measured. Selected significant materials were measured in the research centrum of Josef Ressel in Utechov. Sorption and desorption characteristics of façade's mineral wool and timber insulation were measured by dynamic vapour sorption. The method uses a small sample of material, which is continuously measured in time with variable ambient conditions. This approach offers faster and more accurate results [2].



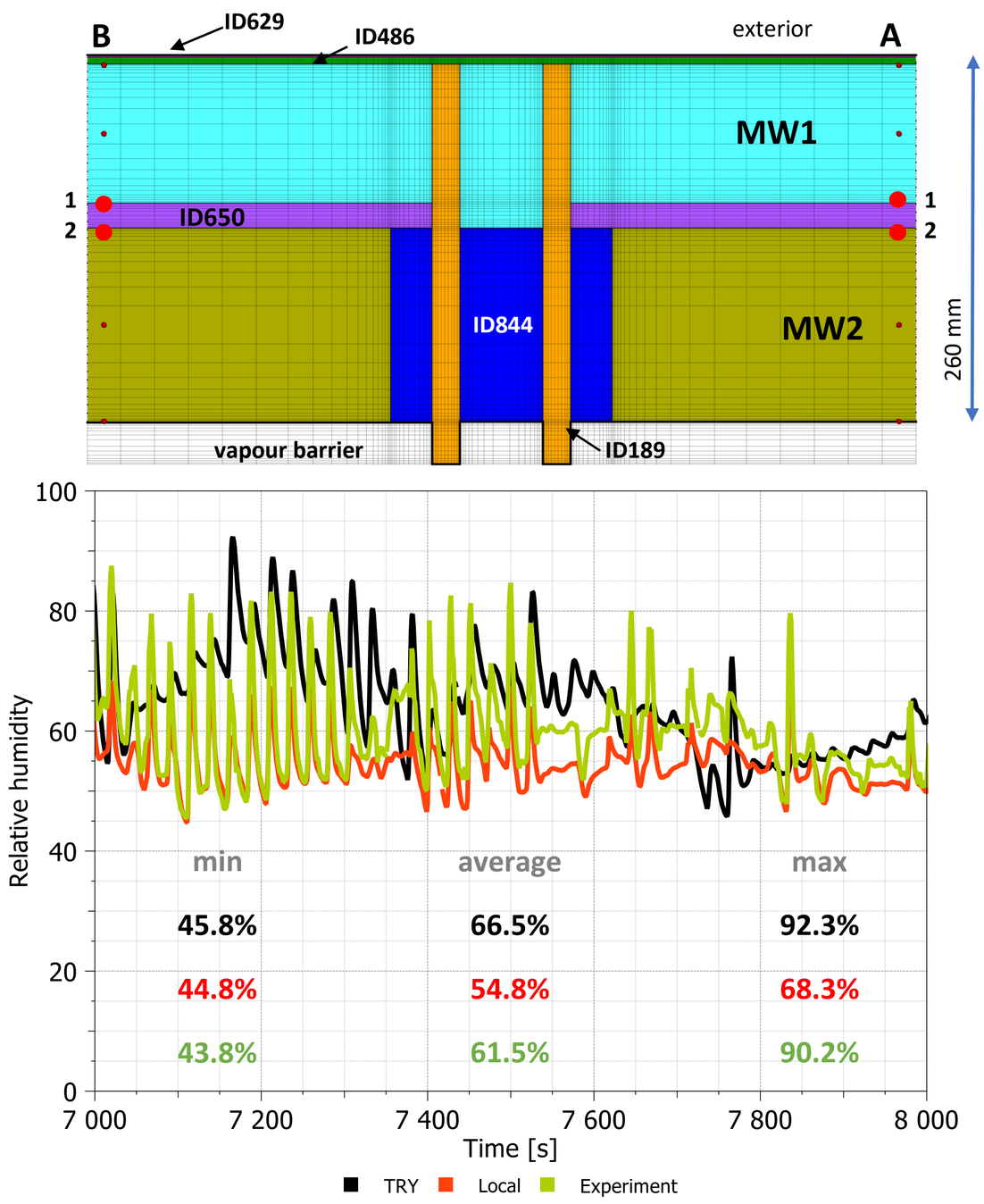
Dynamic vapour sorption experiments a) sample preparation, b) results – sorption and desorption isotherms, c) DVS equipment

Thermal conductivity of insulation was measured by a transient - dynamic method by ISOMET device with needle probe. The method is based on dynamic response of the material to the heat pulse in a semi-infinite space. The method was originally developed for soils measurement [3], [4], but it could be applied for fibre insulation and loose material also. Relation between thermal conductivity, moisture and temperature were investigated.



ISOMET probe with sample on left, results on right

Twelve testing composition are measured since January of 2021 with boundary condition in interior as well as in exterior. Data of selected compositions were used for verification of the numerical model. Model was prepared in Delphin software, which is developed by Technical University in Dresden



Scheme of test components and results of numerical model

Simulation results displayed good compilation with data measured in control points. These results will assist in the understanding of hydrothermal regime and redistribution of moisture in timber components and could be used as a benchmark for testing of algorithms.

REFERENCES

[1] Slávik, R. and Čekon, M. 2019. Vapor diffusion in wood frame wall: Case study of vapor barrier performance [online]. 2019. B.m.: AIP Publishing. Available at: doi:10.1063/1.5120160

[2] Slávik, R.; Struhárová, A.; Čekon, M. Reliability Study of Equilibrium Moisture Content Methods for Sorption/Desorption Isotherms Determination of Autoclaved Aerated Concrete. Appl. Sci. 2021, 11, 824. https://doi.org/10.3390/app11020824

[3] ASTM D5334-14 "Standard Test Method for Determination of Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe Procedure," ASTM International (2014).

[4] IEEE 442-17 "IEEE Guide for Thermal Resistivity Measurements of Soils and Backfill Materials," IEEE Power and Energy Society (2017)

ACKNOWLEDGEMENT

This research was conducted within Internal Grant Agency MENDELU by project TP_20200009 Full-scale test infrastructure for modern timber components