Moisture Risks in Multi-layered Walls - Comparison of COMSOL and WUFI®PLUS Models with Experimental Results

Ansis Ozolins[1]*, Andris Jakovics[1], Janis Ratnieks[1]

[1]Laboratory for Mathematical Modeling of Technological and Environmental Processes, University of Latvia

*ansiso@inbox.lv

COMSOL
CONFERENCE
ROTTERDAM2013

Main goal

Estimating risks of mould growth under Latvian climate conditions using 3 different approaches:

- experimental results in real test houses
- software WUFI®PLUS (3D model)
- COMSOL (1D model)

Governing equations

Heat transfer
Moisture transfer

$$\frac{\partial}{\partial x}\left(\lambda \frac{\partial T}{\partial x}\right) + h_v \frac{\partial}{\partial x}\left(\delta_p \frac{\partial(\varphi P_{sat})}{\partial x}\right) = \rho_s(c_s + wc_w)\frac{\partial T}{\partial t}$$

$$\frac{\partial}{\partial x}\left(D_\varphi \frac{\partial \varphi}{\partial x}\right) + \frac{\partial}{\partial x}\left(\delta_p \frac{\partial(\varphi P_{sat})}{\partial x}\right) = \rho_s \frac{dw}{d\varphi}\frac{\partial \varphi}{\partial t}$$

Variables: temperature and relative humidity

$$T(t,x), \varphi(t,x)$$

see "Simultaneous Heat and Moisture Transport in Building Components." (Kunzel, H.M.) for details

Test stands of houses

Five test stands was built for the first time in Riga, Latvia. These test stands can help to analyse moisture risks in a multi-layared wall since moisture can negatively influence building's sustainability and human health
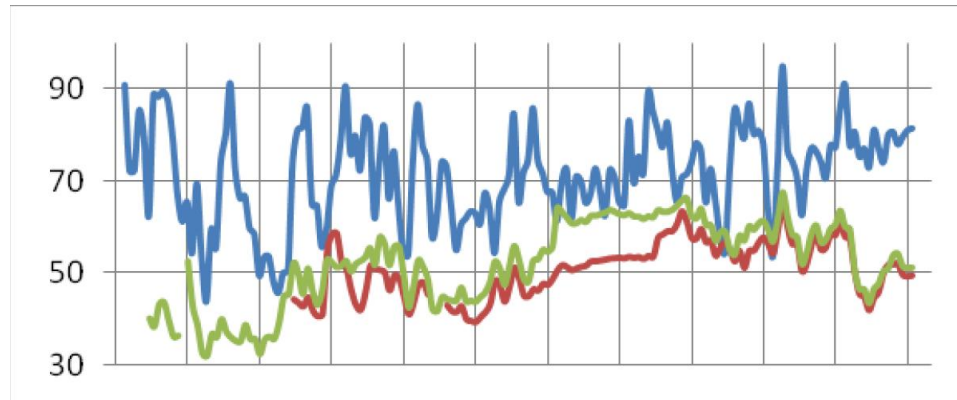
Description of building construction walls

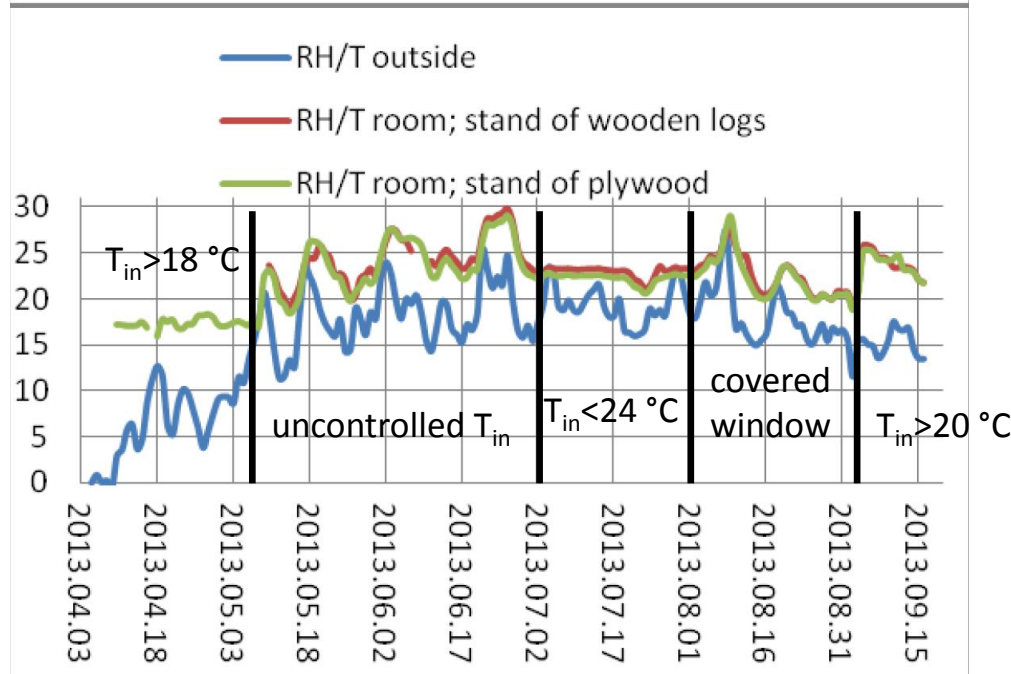| Test stands	d m	λ W/(m·K)	μ [-]
Stand of plywood panels Outside			
Plywood	0.02	0.17	700
Mineral wool	0.2	0.036	1
Plywood	0.02	0.17	700
Fibrolite	0.075	0.068	2
Lime plaster	0.015	0.7	7
Stand of wooden logs Outside			
Wooden logs	0.2	0.13	130
Mineral wool	0.2	0.036	1
Wooden log	0.04	0.13	130
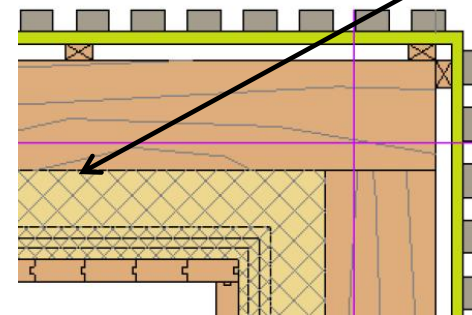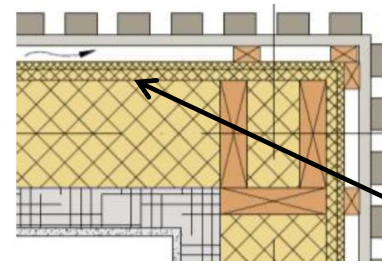
critical places

Outside and inside climate

daily average relative humidity and temperature

Different room climate were ensured: uncontrolled indoor temperature, heating, cooling, covered windows. Indoor relative humidity has been fluctuated for free floating conditions all the time period
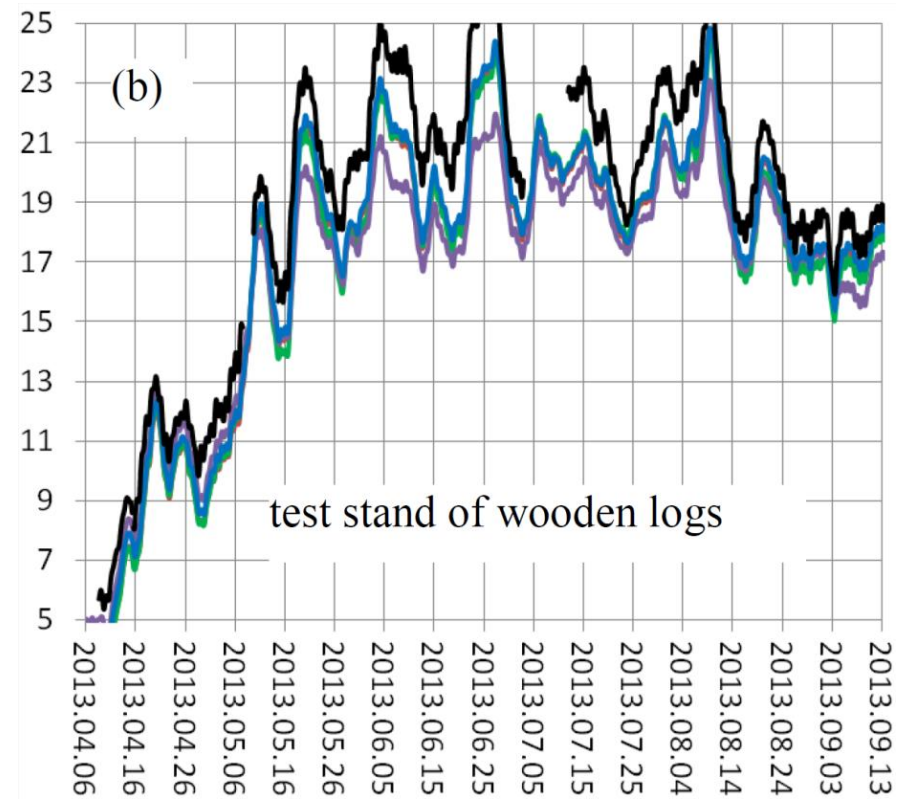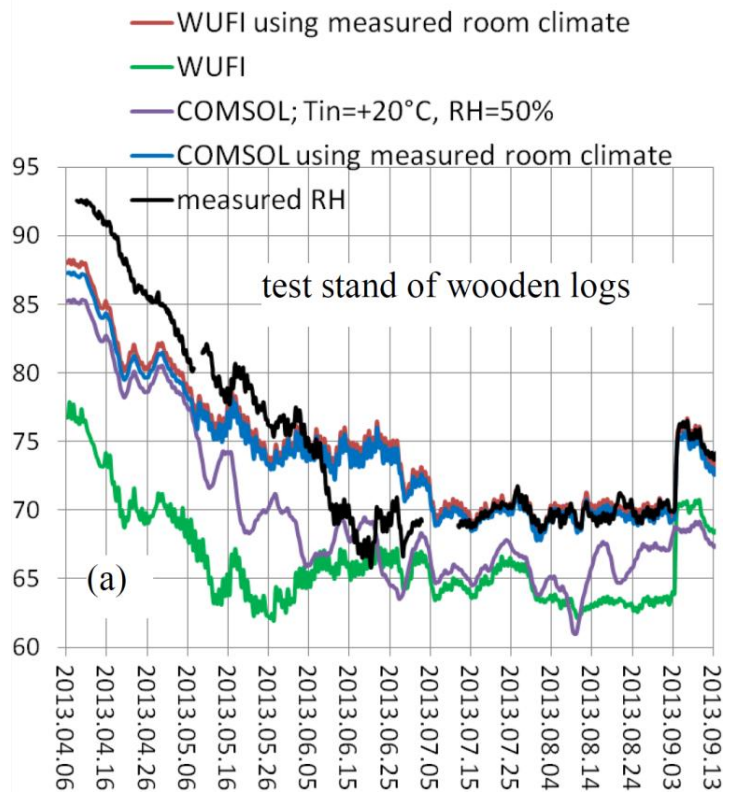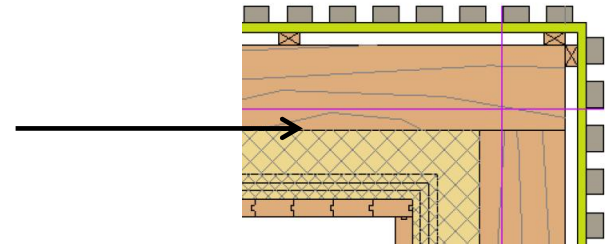
Obtaining indoor climate

Several approaches were used for estimating room climate :

- measured indoor relative humidity and temperature (WUFI®PLUS, COMSOL)

- calculated φ_{in} and T_{in} (WUFI®PLUS)

- constant φ_{in} and T_{in} (COMSOL)

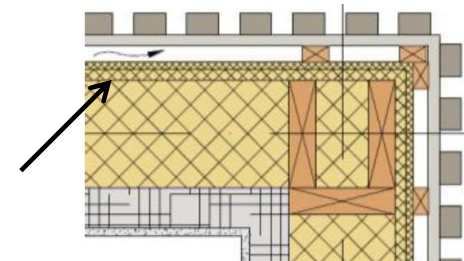# Moisture risks for the test stand of wooden logs

Critical place

Moisture risks for the test stand of plywood
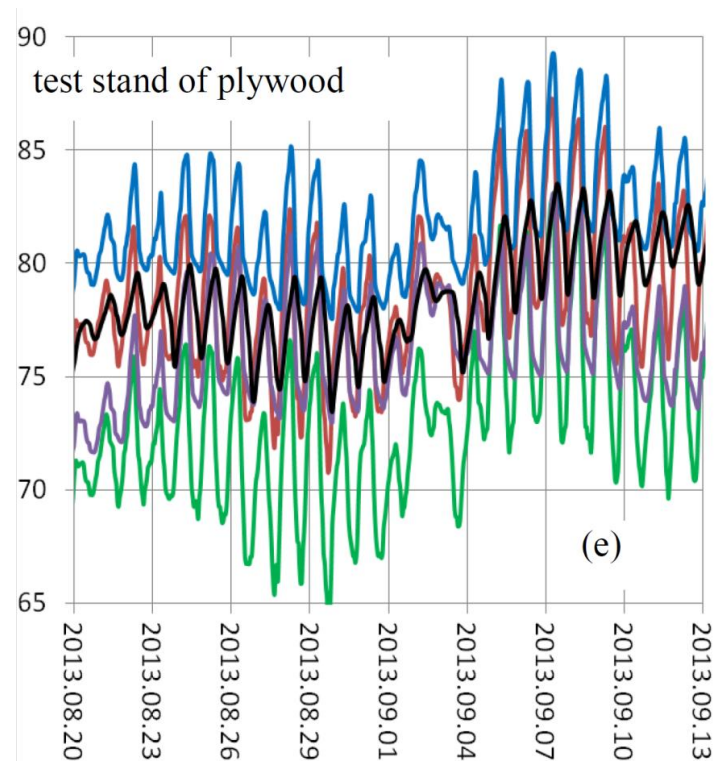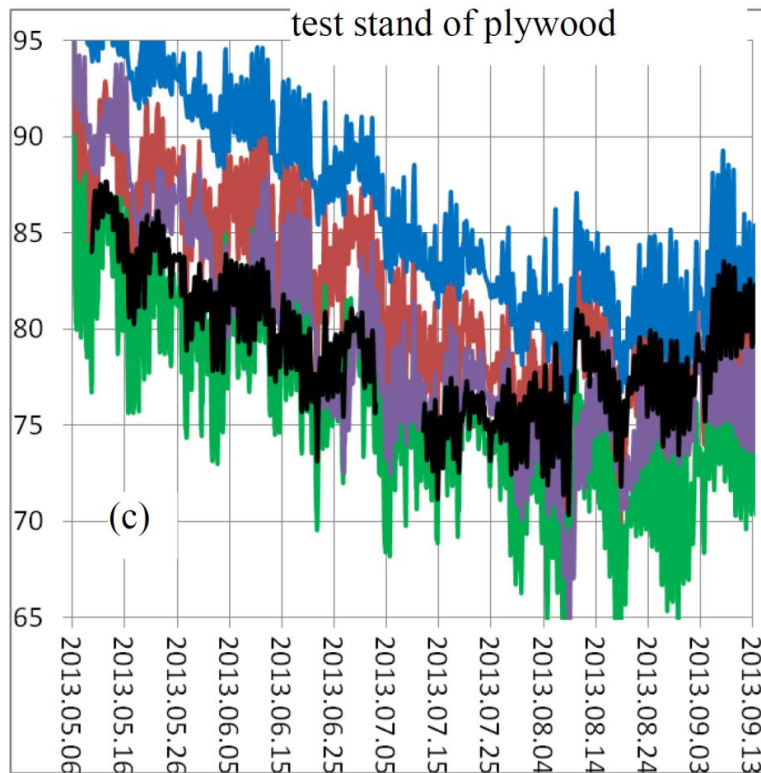
Critical place

Conclusion

- Simple 1D model, implemented in COMSOL Multiphysics, works well for estimating mould growth risks in a multi-layered building constructions.

- If high risks of condensate formation in a construction could also occurs, WUFI PLUS shows better results in a comparison with measured results.

Further works

- The comparison of measurements with thus obtained by WUFI®PLUS and COMSOL Multiphysics for a longer time period.

- Coupled heat and moisture simulations using 2D and 3D model implemented in COMSOL Multiphysics

Thanks for attention!