KAUNO TECHNOLOGIJOS UNIVERSITETAS

The effects of naturally varying climate on timber moisture content

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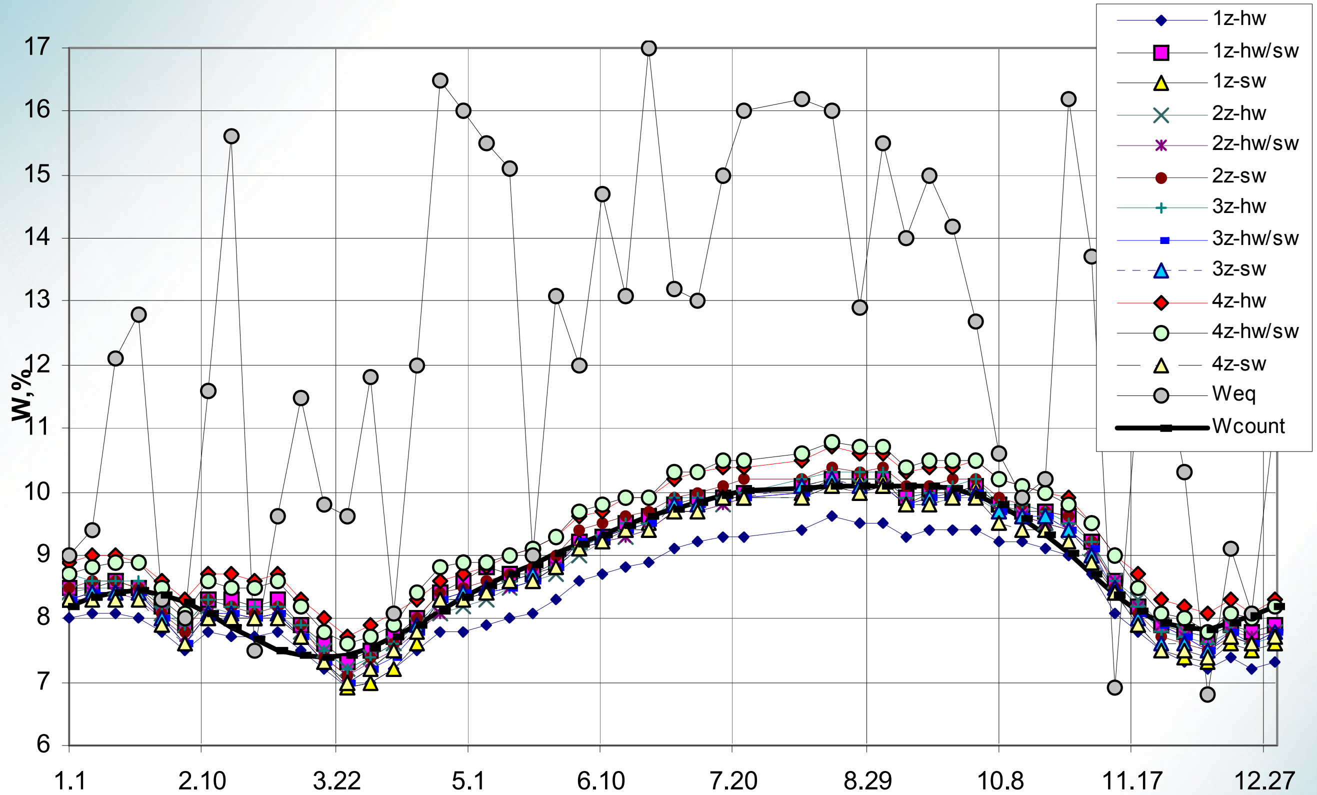
Question?

Is the mechano-sorptive effect of periodical wetting-drying cycles in alternating humidity and increased creep during drying and decreased during wetting adequately interpreted or concerned at all? In a moisture as action respect?

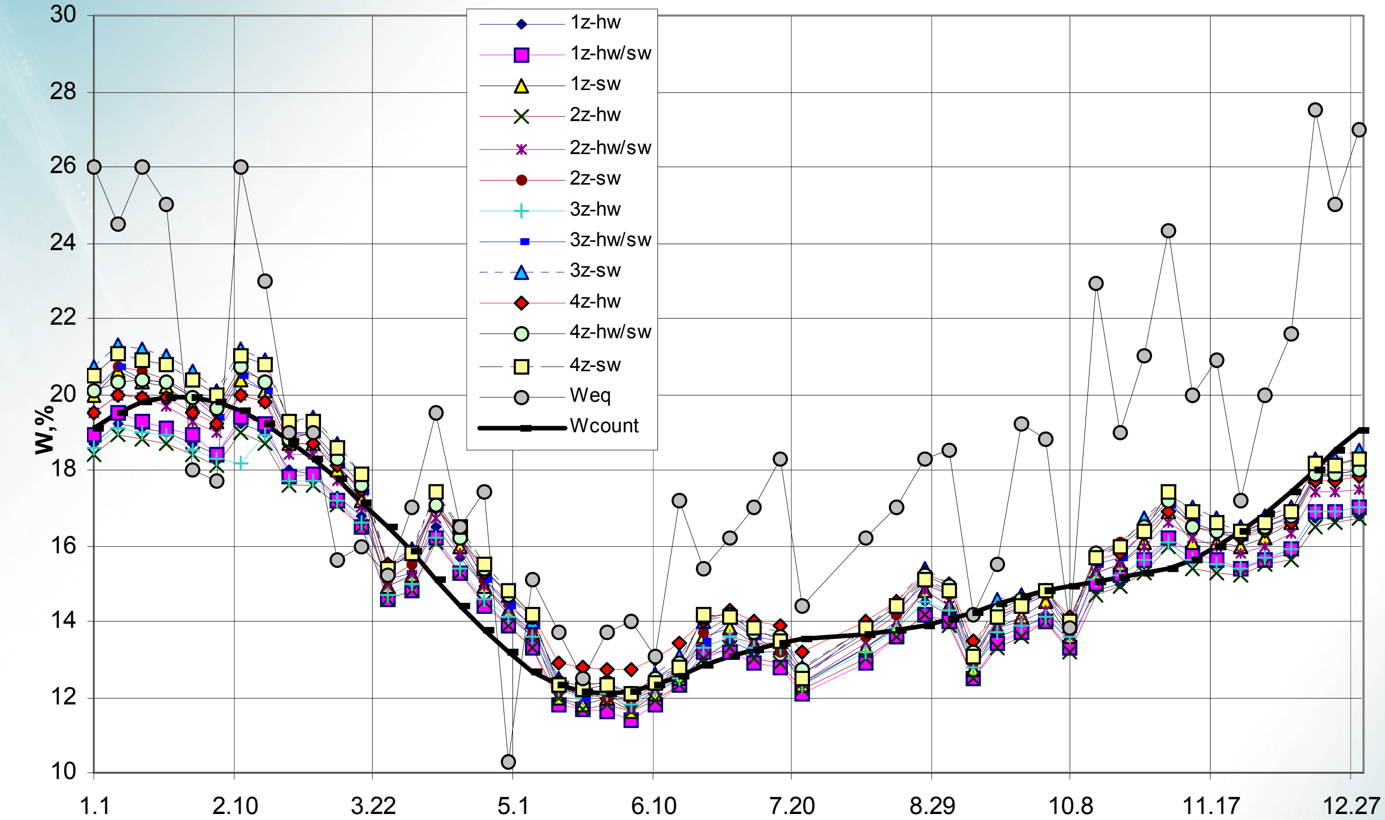
Some ideas from our research concerning moisture content migration in timber under ambient air conditions are in slides 2-6.

Change of moisture content in pine wood samples ***indoors*** (cut from different tree stem places). Note significant (10-15 %) differences for sapwood and heartwood samples



Test samples were cut from central yield boards at four different height zones - *1z, 2z, 3z,* and *4z* - of the tree stem (1 zone - near the stump, 2 zone - 3,2-3,7 m, 3 zone - 6,3-6,8 m, 4 zone - 9,5-10 m away from the stump), while transversely - from heartwood (*hw*), from sapwood (*sw*) and partly from heartwood - partly from sapwood (*hw-sw*).

Change of moisture content in pine wood samples ***outdoors*** (cut from different tree stem places). Note significant (15-20 %) differences for sapwood and heartwood samples



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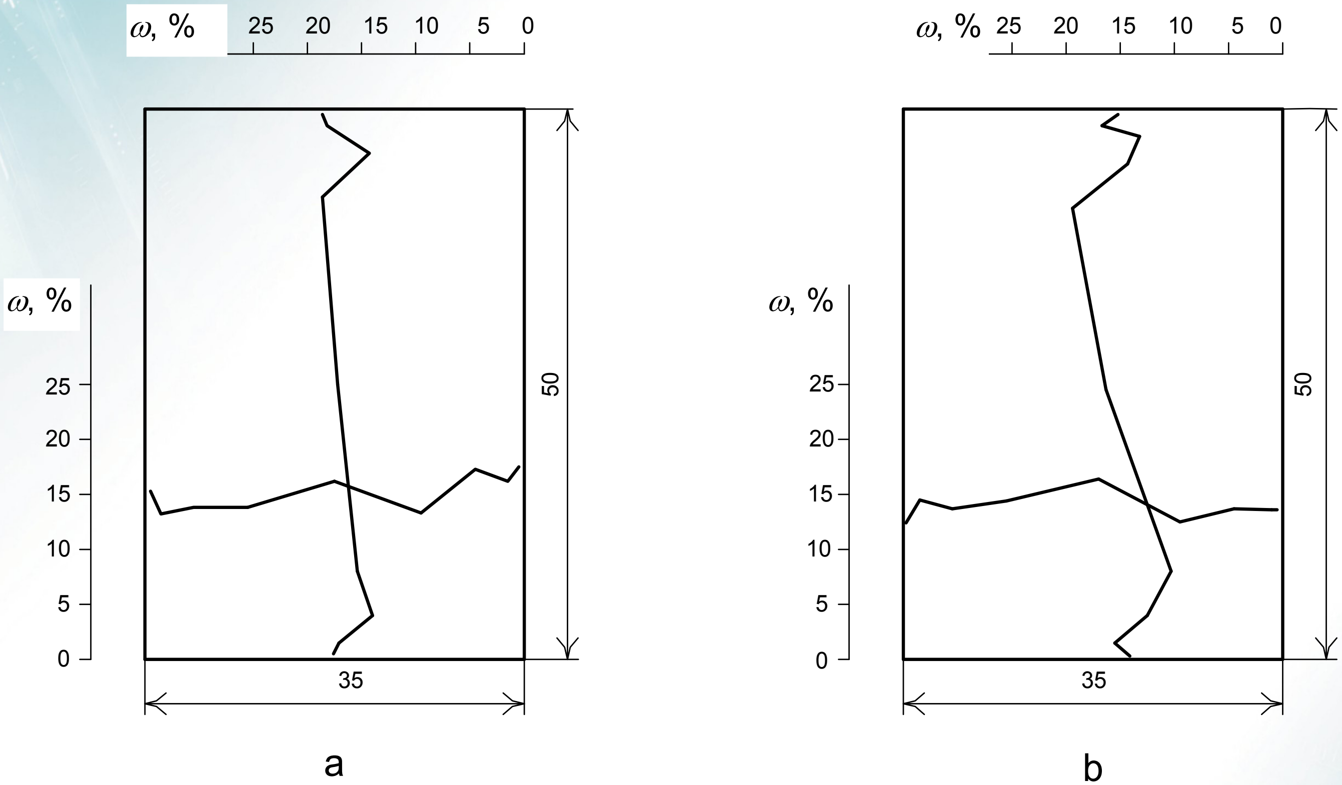
Polynomial model for predicting annual variation of factual moisture content in softwood timber (graphs in slide 1 and 2)

$$W_f = \frac{a_0}{2} + \sum_{j=1}^{m} \left(a_j \cos j(n-1)\left(\frac{2\pi}{T-1}\right) + b_j \sin j(n-1)\left(\frac{2\pi}{T-1}\right) \right)$$

where a_0, a_j, b_j – coefficients (in table); T - number of days per year; n - day number in a year.

Values of trigonometric polynomial coefficients		
Coefficient	indoors	outdoors
a_0	17.64	12.47
a_1	-0.852	0.164
a_2	0.106	-2.116
a_3	0.082	-2.556
a_4	0.045	-1.727
b_1	-0.880	-9.085
b_2	0.256	-1.462
b_3	0.328	-2.358
b_4	0.155	1.249

Difference of moisture content in sample cross section indoors (unheated) in March (within one week)



Significant moisture content variations occur in timber surface layers. Similar proportion could be expected for shrinkage stresses values in these layers.

Lessons:

Moisture changes are related to:

Geographical location (differences 15-25 %)

Species - Growth properties (10-30 %)

Sizes (up to 25 % for twofold size factor)

Coating (reduces by up to 30 %)

Drying method, schedules, history (minor, but objective!)

Moisture changes settle after 5-6 years in exploitation (reduced by 15-20 %)

Note: The figures above are average and presented for clarifying the main ideas and conclusions for discussion

Lessons:

In engineered wood products reological properties of timber laminations (elements) influence also the moisture related stress-strain properties of whole timber product. Having in mind natural variation of strength-stiffness properties across and along tree stem (e.g., for freshly felled tree MOE and MOR is about 40 % lower for heartwood than sapwood; heartwood displays brittle failure mode while sapwood maintains resistance at higher strains) the scenarios and quantification of the moisture related behavior of timber structural element is more than sophisticated and clearly needs further research.

Conclusion

A moisture change is strongly related to the wood element size, growth (tree physiology), mechanical, heat treatment and many other properties and factors. Ideally modeling and predicting of performance of timber load bearing element as well as practical recommendations of accounting of the effects of climatic exposures (moisture action) with secure precision needs elaboration of models linking stress-strain/moisture/growth properties.

Dream!: for narrowing of performance properties variability it would be useful to consider the possibilities to integrate log conversion with the following strength grading and optimal localization of separate timber pieces with standard properties in the end-use timber structure or engineered wood product.