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CHANGES IN PHYSICAL PROPERTIES OF WOOD DAMAGED BY ACTIVITIES OF WOOD-DAMAGING FUNGI

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Abstract: *This paper presents results of experimental, laboratory establishment of the extent of changes in physical properties (swelling, water absorbability) of timber (spruce) damaged by the activity of wood-damaging fungi. The experiment was carried out using standard test samples (20 x 20 x 30 mm) prepared from new timber and subsequently exposed to the activities of wood-damaging fungi (Serpula lacrymans, Trametes versicolor) under optimal growth conditions for the period of 15 to 60 days. Changes in physical properties were observed in the damaged samples as per the CSN 490126 and CSN 490104 Czech National Standards. The experiment proved significant changes in the observed properties depending on the fungi type and duration of the activity thereof.*

Keywords: ***Wood, timber, physical properties wood-damaging fungi.***

1. Introduction

A lot of destructive biological agents affect wooden structural elements inbuilt in buildings. Among the most important destructive agents are wood-damaging fungi. Their morphology and principles of their destructive activity (decomposition of wood) are relatively well described in expert literature (Schmidt 2006, Reinprecht 1996). Less attention is paid to changes in physical or mechanical properties of wood due to their activities or the attention is focused on the types of wood-damaging fungi and tree species that are practically not used in construction industry (Reinprecht 2008).

The carried out experiment was aimed at detecting the decrease in physical properties of spruce wood due to the activities of cellulosevorous and lignivorous fungi. As a representative of a group of cellulosevorous fungi (brown rot) *Serpula lacrymans* was selected, as a representative of the lignivorous group of wood-damaging fungi (soft, white, spongy rot) *Trametes versicolor* was selected. Within the experiment, what was monitored was a change in selected properties depending on the duration of exposure to wood-damaging fungi.

2. Methods and results

Test samples of the size of 20 x 20 x 30 mm with clearly discernible fibre orientation were produced from dried spruce lumber (CSN 490101). The produced samples were dried in a drier at 103±2°C to a constant weight (at zero moisture) and then weighed and precisely measured. Subsequently, they were conditioned in a climatic chamber to achieve moisture content of wood of 12%.

Test samples were then placed into cultivation boxes with wort culture medium and active mycelia growth of the given wood-damaging fungus. The culture, at the time the samples were inserted, was 7 days old. Samples were in series by thirty pieces (for each type of the fungus and the time of activities) exposed to the activities of the wood-damaging fungi for the periods of 15, 30, 45 and 60 days (Fig. 1). Cultivation was taking place in a laboratory environment under optimal growth conditions (Bayer, Týn 1996). Upon expiry of the determined period of cultivation, samples were removed from cultivation boxes, washed and slowly dried until the moisture content of wood of 12% was achieved (Fig. 2).

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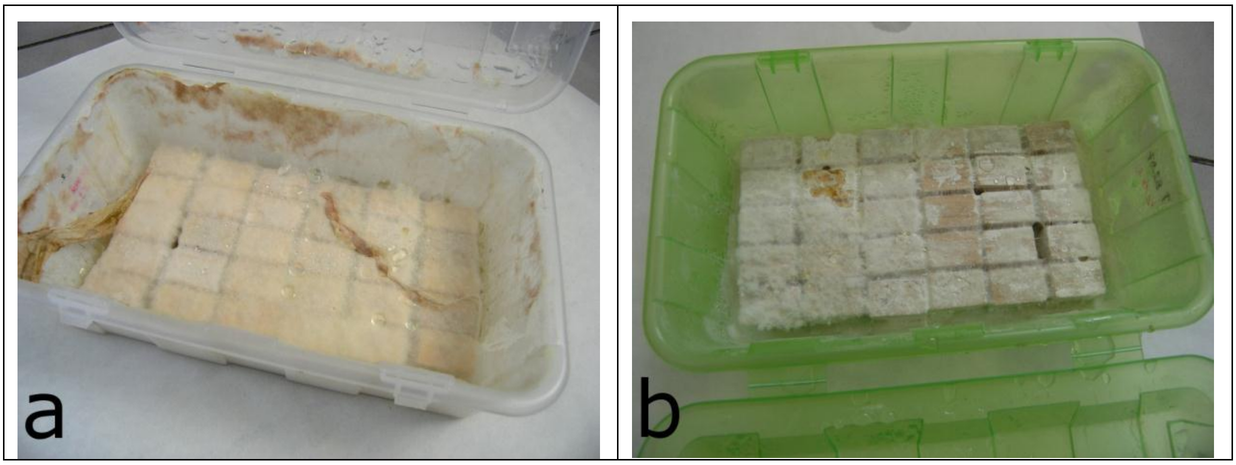

Fig. 1: Cultivation of samples in cultivation boxes after 45 days of exposure to wood-damaging fungi a) Serpula lacrymans, b) Trametes versicolor.

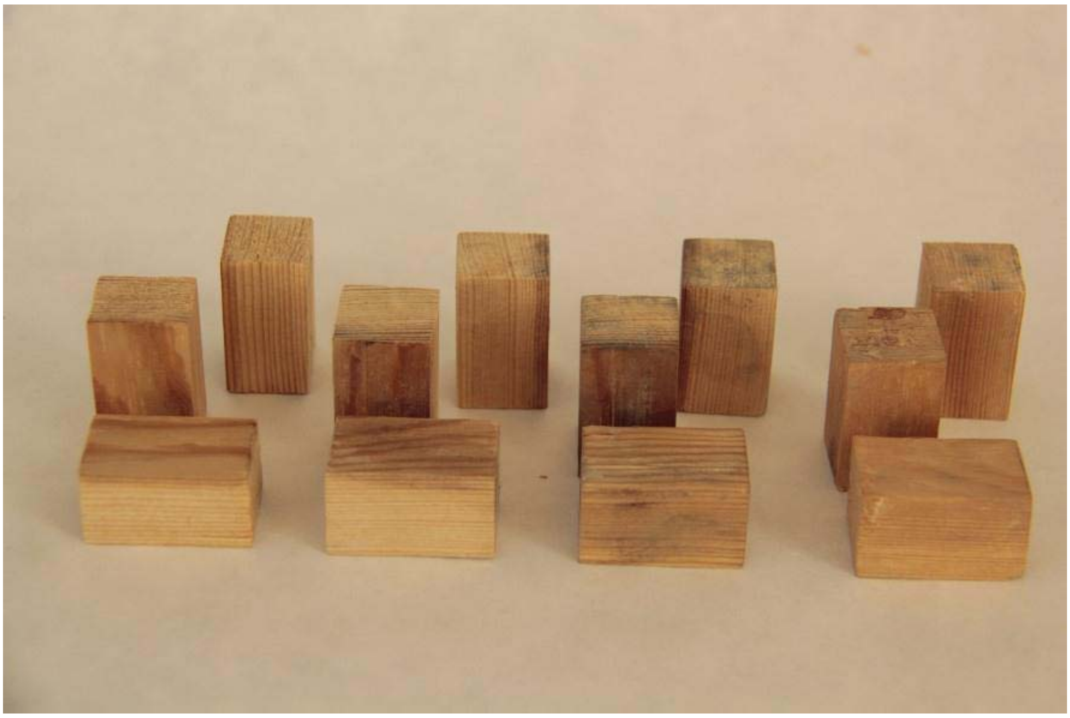

Fig. 2: Test samples after the end of the damage by wood-damaging fungi (Trametes versicolor - 30 days).

Later, the swelling test (CSN 490126) and the absorbability test (CSN 490104) were simultaneously carried out using the damaged samples and reference samples (without any damage). Test samples were immersed in a container with distilled water so as not to touch the bottom, walls and each other and were sunk at least 10 mm below the surface (ensured by a net). In the samples, what was continuously measured was a change in dimensions (the swelling test) until the stabilized condition was reached, i.e., until the difference between two consecutive measurements (within 24 hours) was less than 0.02 mm. At the same time, the samples were weighed (the absorbability test) until the stabilized condition was reached, i.e., until the difference between two consecutive measurements (within 24 hours) was less than 0.1%. After the stabilized condition was reached, all the tested samples were measured and weighed and changes in the observed physical properties evaluated (Fig. 3.).

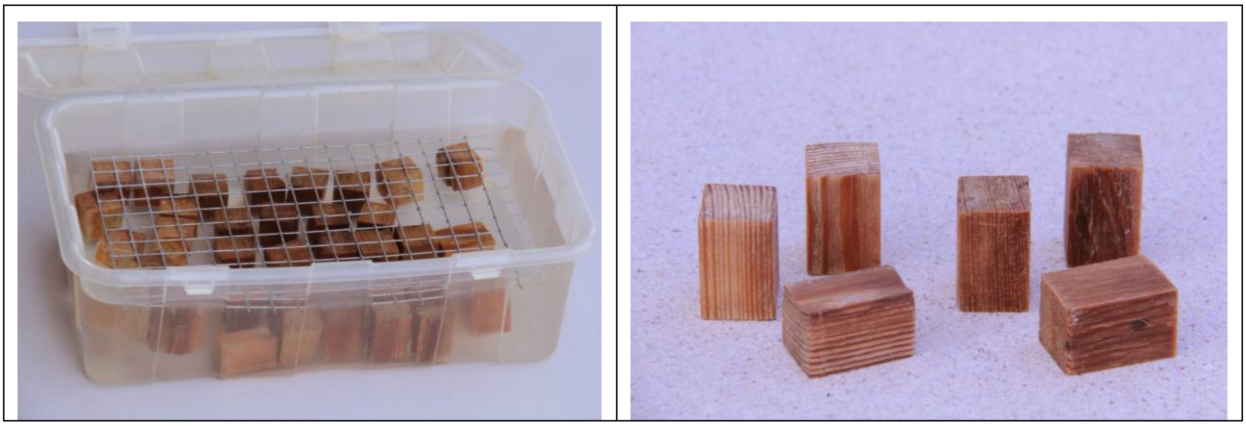

Fig. 3: Test samples during the test of physical properties

The absorbability of wood, $\mathbf{W_{max}}$, as a percentage, is calculated using the following formula:

$$\mathbf{W_{max} = ((m_W - m_0) / m_0) * 100} \quad (1)$$

Where $\mathbf{m_0}$ [g] is the weight of a test sample after having been dried to zero moisture and $\mathbf{m_W}$ [g] is the weight of the test sample after soaking.

The largest swelling of wood $\boldsymbol{\alpha_{max}}$ as a percentage is calculated using the following formulas:

$$\boldsymbol{\alpha_{max\,(r,\,t,\,a)} = ((l_{max\,(r,\,t,\,a)} - l_{min\,(r,\,t,\,a)}) / l_{min\,(r,\,t,\,a)}) * 100} \quad (2)$$

For the radial, tangential and along the fibres directions (r, t and a coefficients).

And according to the following formula - for the total volume (**V** coefficient):

$$\boldsymbol{\alpha_{max\,(V)} = ((l_{max\,r} * l_{max\,t} * l_{max\,a}) - (l_{min\,r} * l_{min\,t} * l_{min\,a})) / (l_{min\,r} * l_{min\,t} * l_{min\,a}) * 100} \quad (3)$$

Where $\mathbf{l_{max}}$ is the dimensions of test specimens for moisture content equal to or greater than the limit of hydroscopicity of cell walls (after soaking) and $\mathbf{l_{min}}$ is the dimensions of test specimens during drying to zero moisture.

The identified average values of observed physical properties of spruce wood and their changes due to the effects of selected wood-damaging fungi for periods of varying duration are summarized in Tab. 1.

Tab. 1: Changes in physical properties of spruce wood (absorbability, swelling) caused by exposure for varied periods of time to wood-damaging fungi Serpula lacrymans and Trametes versicolor.

		Serpula lacrymans				Trametes versicolor				Reference
		15 days	30 days	45 days	60 days	15 days	30 days	45 days	60 days	
absorbability	[%]	95,9	127,4	151,1	153,1	107,4	140,7	146,4	178,9	59,5
comp. to the ref. samples	[%]	+ 61	+ 114	+ 154	+ 157	+ 80	+ 136	+ 146	+ 200	
swelling	[%]	15,9	16,2	17,9	18,9	18,7	13,6	13,4	12,5	12.1
comp. to the ref. samples	[%]	+ 31	+ 34	+ 47	+ 56	+ 54	+ 12	+ 11	+ 3	

3. Conclusions

The experiment has proved a considerable impact of destructive activities of wood-damaging fungi on physical properties of spruce wood used for building purposes. In case of effects of the cellulosevorous wood-damaging fungus Serpula lacrymans, there was an overall increase in absorbability of up to 153,1% in samples exposed to the wood-decaying fungus for 60 days during the experiment (compared to the reference samples). In swelling, there was an increased increase in dimensions (compared to reference samples) of up to 56% in samples exposed to the activities of the wood-damaging fungus for 60 days. In case of the effects of the lignivorous wood-damaging fungus Trametes versicolor, there was, in the course of the experiment (compared to reference samples), an overall increase in absorbability of up to 200% in samples exposed to the effects of the wood-damaging fungus for 60 days. In swelling, there was an increased increase in dimensions (compared to the reference samples) of up to 54% in samples exposed to the activities of the wood-damaging fungus for 15 days.

The experiment has proved a significant impact of activities of wood-damaging fungi on physical properties of wood. However, it is necessary to take into account the fact that it took place in the laboratory (sterile) environment under optimal growth conditions. In the real environment of buildings and wooden structures, where the wood degradation process is influenced by a number of other factors, the speed and the extent of changes in physical properties may be considerably different.

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References (EM Reference Chapter style)

Bayer J., Týn Z. (1996) Ochrana Dřeva, Grada Publishing, Praha, CR, 97 pp. ISBN 80-7169-275-1

Reinprecht L. (1996) Procesy degradacie dreva, 1. vydanie, *TU Zvolen*, Zvolen, Slovakia

Reinprecht L. (2008) Ochrana dreva, *Vydavaťelstvo TU vo Zvolene*, Zvolen, Slovakia, 453 pp. ISBN 978-80-228-1863-6

Schmidt O. (2006) Wood and Tree Fungi. *Springer Verlag*, Berlin, Heidelberg, Germany, ISBN 3-540-32138-1