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New Test Method for Assessing the Decay Resistance of Natural Fiber Insulation and Wood-Based Materials

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Background

The research projects In2EuroBuild [1] and ThermNat [2] demonstrated that the biological durability of various wood-based materials and natural fiber insulations differs significantly and, in some cases, can even be better than that of solid wood; therefore, these materials require individual assessment and evaluation. For moisture control design purposes, hygrothermal simulations using tools such as WUFI® represent the state of the art and are often mandatory for moisture-sensitive wood constructions. A reliable assessment of moisture-related durability requires appropriate limit values or predictive models. While limit curves for the decay risk of softwood are already available [3,4,5], corresponding criteria for wood fiber insulation materials and wood-based panels have not yet been established. When the commonly used moisture limit value for wood-based materials of 18% by mass or the decay limit developed for solid wood [6] is applied, these materials are often assessed too negatively (Figure 1). A newly developed test method now enables a more accurate determination of material- specific durability and facilitates assignment to suitable limit curves.

New Prediction Model for Wood Decay Risk

The WUFI® Bio model for the transient assessment of mold growth has been successfully applied in practice for more than two decades. The fundamental principle of this transient prediction model for fungal growth has now been adapted to assess the development of wood decay fungi.

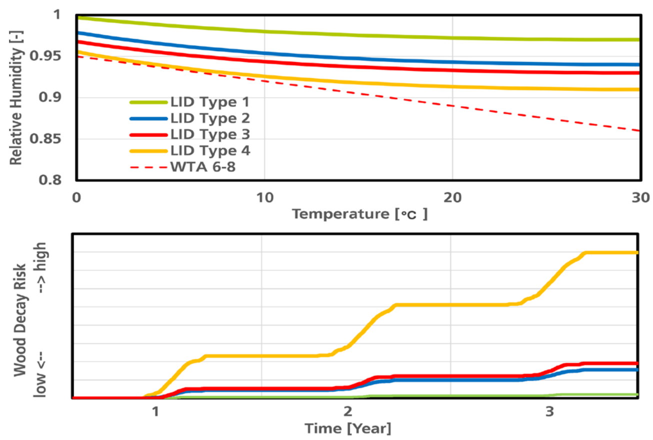

Figure 1: Comparison of the various limit curves for wood decay (top) and the corresponding evaluation of wood decay risk (bottom). The red curve represents softwood [3]. The dashed line is the limit curve according to WTA guidelines [5].

The following key parameters for wood decay processes were determined within the mentioned research projects:

- Minimum hygrothermal conditions under which wood-decay fungi can degrade a specific material, referred to as the Lowest Isopleth for Decay (LID curve).
- Specific decay rate, reflecting the susceptibility of the respective wood-based material.

Since comprehensive wood decay investigations are both time-consuming and costly, the methodologies developed within the research projects were transferred into a simplified laboratory test procedure suitable for practical application.

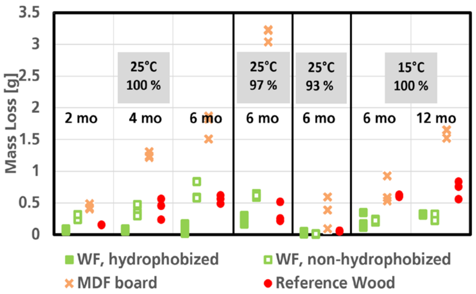

Figure 2: Measured absolute mass losses (in grams) of the investigated materials after the specified incubation period (2–12 months) under various climatic conditions.

Laboratory test

The new test method was validated using wood fiber insulation (WF), both with and one without hydrophobic treatment, and a MDF board compared with softwood (pine sapwood) as reference material. The samples were inoculated with the brown rot fungus Coniophora puteana, a common test fungus identified as a critical representative of wood decay. The specimens were exposed for up to twelve months to a temperature favorable for fungal activity at relative humidity levels of 100 % to determine the decay rate, and 93% or 97% to determine the safe moisture conditions without decay. In addition, the combination of 15°C and 100% RH was investigated; however, this condition proved unnecessary for the eva-luation procedure. Inoculation was performed using pre-infected pine wood dowels (see cover image). To quantify degradation, the specimens were periodically removed, oven-dried, and weighed to determine the resulting mass loss caused by fungal decay. The relative humidity in the test chambers was adjusted using distilled water for 100% and saturated salt solutions for the lower RH levels. In future tests, 91% RH and 94% RH can also be used for materials with different susceptibility levels.

Results

The measured mass losses are shown in Figure 2. Since the commonly used evaluation based on mass loss in percent depends on the ratio of added fungal mass to specimen mass and inevitably leads to a higher "decay risk" for low-density fiber insulation materials than for solid wood, this figure can be misleading. Therefore, absolute mass loss values are used instead. Among the investigated materials, the MDF board consistently exhibited the highest mass losses, whereas the hydrophobized wood fiber insulation material showed the lowest losses, as expected. The non-hydrophobized insulation material showed losses comparable to those of the reference wood. The decay susceptibility of the materials was derived from the decay rate at 25°C and 100% RH by means of regression lines and normalized to that of the reference wood. The normalized values, as presented in Table 1, can now be integrated into the wood decay prediction model, enabling a material-specific assessment expressed as a decay risk index.

Material	Decay rate	
	measured [g/month]	normalized [-]
Reference Wood	0.1	1
WF, hydrohobized	0.01	0.1
WF, non-hydrophobized	0.1	1
MDF board	0.32	3.2

Table 1: Decay rates of various materials at 25°C and 100% RH in grams per month and normalized to the decay rate of softwood as the reference material.

Summary

The new test method provides both the material-specific decay limit curve (LID) and the decay rate as a risk indicator in comparison to the pine sapwood reference. The four different humidity levels enable a simple classification of the investigated materials (Figure 1). With the prediction model, the risk of wood decay can be assessed based on transient hygrothermal simulation results. This allows the range of applications for materials made from renewa-ble resources to be expanded, whose use has previously been unnecessarily restricted by overly conservative limit values.

Outlook

The test procedure is now available and can be applied to a wide range of natural fiber insula-tion materials and wood-based products. The results can be integrated into the database of the post-processing tool WUFI® Decay (avai-lable at www.wufi.de/en/wufi-decay) thereby enabling transient decay assessment. The most reliable results currently relate to cases in which no risk of mass loss is predicted. Further assessments that go beyond this can be developed and validated in the future based on additional practical experience and by comparing them with findings from building inspections.

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Literature

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