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Demo project top floor ceiling comparison of esb and OSB boards Hygrothermal Simulation according to DIN EN 15026 withWUFI®

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Hygrothermal Simulation according to DIN EN 15026 with WUFI®

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Project: elka-Holzwerke Variant Comparison

Component: Demo project elka-Holzwerke
top floor ceiling comparison of
esb and OSB boards

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Preface

The subject of the study is a top floor ceiling that has been renovated as part of individual measures eligible for funding through the German Federal Office for Economic Affairs and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle, BEG).

The simulation is conducted using the finite element software WUFI® (Wärme- Und Feuchtetransport, Instationär) developed by the Fraunhofer Institute for Building Physics, taking into account the WTA guidelines 6-1 (Guidance for hygrothermal simulation calculations), 6-2 (Simulation of heat and moisture processes), and 6-8 (Moisture assessment of timber components).

Objective of the Study

The WUFI simulation aims to compare the moisture behavior of the construction by using an esb board compared to an OSB board as the load-bearing layer.

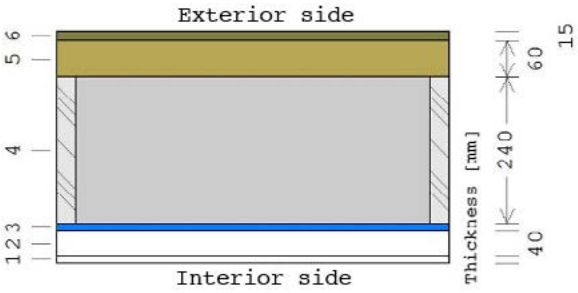
The moisture content of the critical component (in this case, the esb or OSB board) should reach a non-critical level within a reasonable time. Moisture peaks occurring throughout the year must remain below the normatively specified limits, taking into account new findings on temperature- and moisture-dependent wood degradation (WTA 6-8).

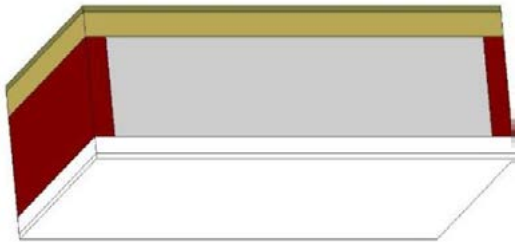
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Construction of the Top Floor Ceiling

The following construction was examined (from top to bottom):

- Comparison of OSB board and esb board
- 60 mm wood fiber insulation board
- 240 mm insulated timber joist: cellulose blown-in insulation WLS 040
- moisture-variable vapor barrier
- air gap as installation level
- gypsum plasterboard





In the one-dimensional WUFI simulation, only the stud cavity is considered as the critical area. The simulated construction is provided in the WUFI output in the appendix.

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Climatic Boundary Conditions

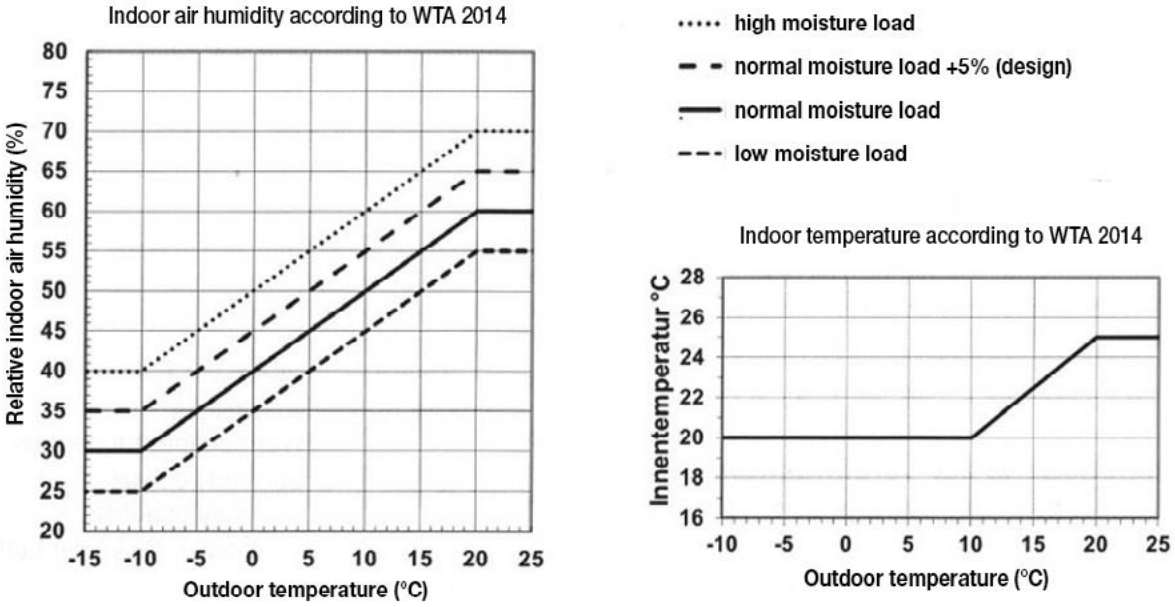
For the outdoor climate, a location-specific local climate was generated based on WUFI climate zone 5 (Kassel), which is applicable to the Morbach location, using the WUFI local climate generator. This climate was then used for the simulation.

The indoor climate was derived from the outdoor climate according to DIN EN 15026. The "normal moisture load" according to WTA guideline 6-2 was chosen, but without the additional design load of +5%. This is because the moisture loads in the ZOB (Center for Public Transportation) building are lower compared to residential buildings, where this additional load would be appropriate for a safety margin.

Moisture Load according to WTA Guidelines 6-2

According to WTA 6-2 - Simulation of heat and moisture processes - the relative humidity for inhabited rooms (including bathrooms) can be assumed using the "normal moisture load" as indicated in the figure below. For the moisture design of external building components of residential buildings, WTA recommends using a moisture load increased by 5%.

Excerpt from WTA guideline:



Derivation of indoor temperature and humidity from residential spaces based on outdoor temperature, each as daily averages.

The complete input data can be found in the WUFI output in the appendix!

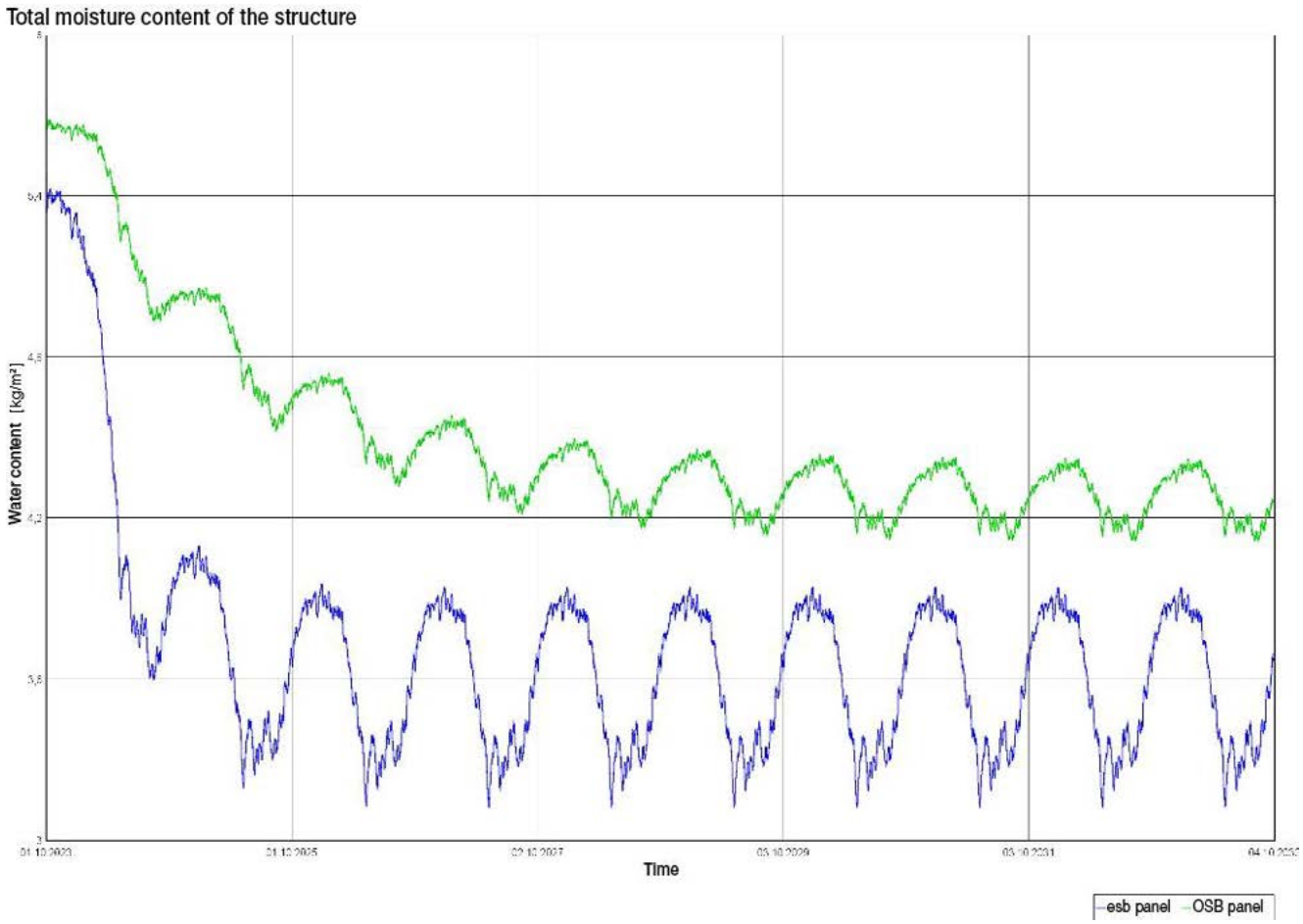
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Evaluation

The final evaluation was conducted over a period of 10 years in hourly steps:

Total Moisture Content

The first step is to evaluate the total moisture content. It should not increase in the long term but reach a steady state within the observation period.



The above chart shows that the total moisture content of the construction steadily decreases throughout the entire observation period and stabilizes at a low level towards the end of the simulation.

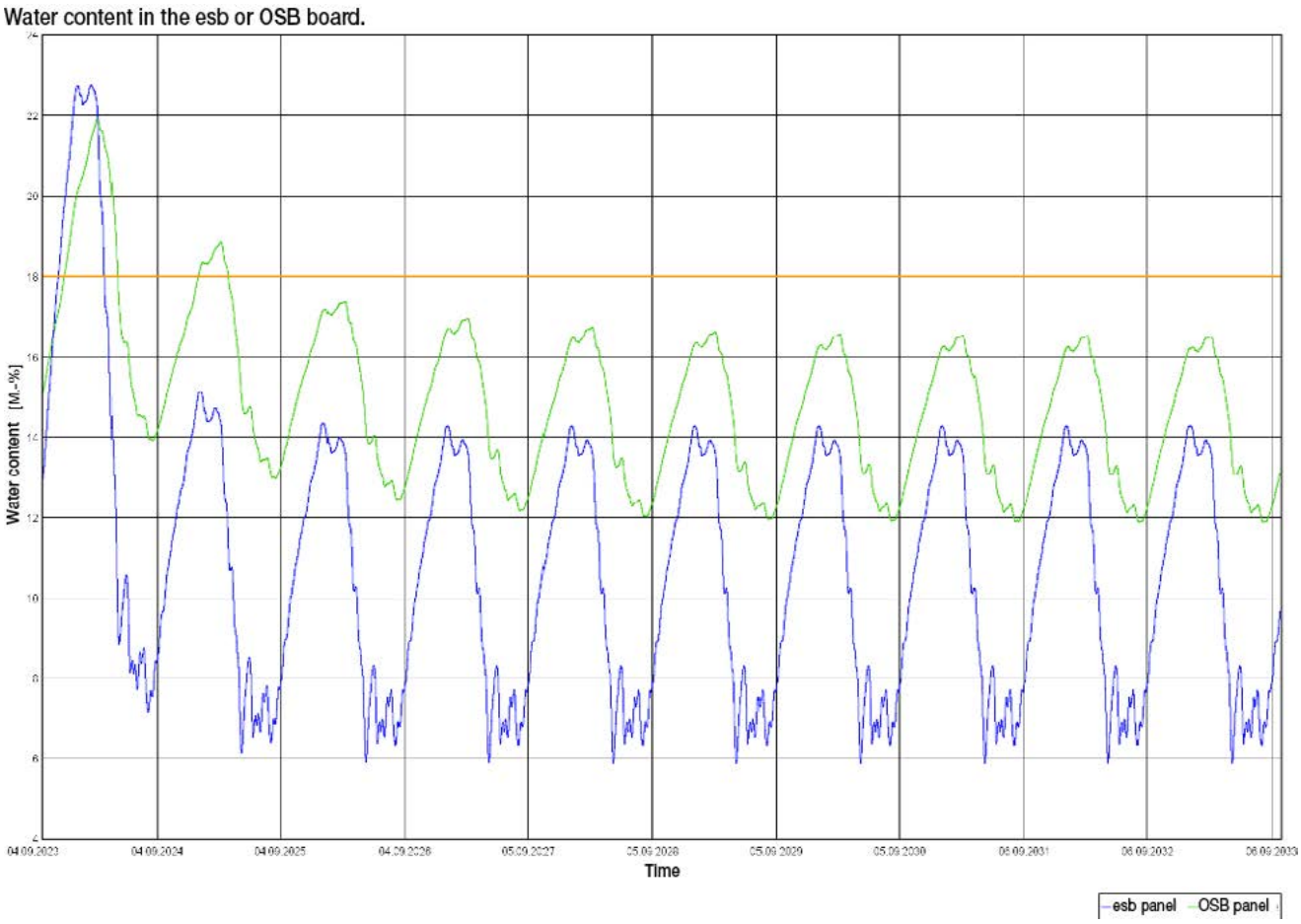
Furthermore, it can be observed that the overall construction with the diffusion-open esb board accumulates significantly less moisture compared to using an OSB board as the load-distributing layer.

This provides the basis for further investigations.

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Moisture Behavior of the Critical Component Layer

In the following evaluation step, the moisture behavior of the critical layer - in this case, the esb or OSB board on the wood fiber insulation board - is examined. The results are shown graphically below:



The upper limit defined by DIN 68800-2 for moisture content is used as the evaluation criterion: 18% mass moisture content for wood-based panels and 20% mass moisture content for solid wood. The applicable threshold of 18% is marked in orange in the graph above.

It is evident that after installation, the moisture content of both the OSB board and the esb board initially increases significantly. However, in the "elka-strong board" variant, the moisture content quickly decreases to a non-critical level. A steady state is reached, with maximum values of only about 14% mass moisture content over the observation period. In the OSB board variant, the winter moisture peaks are slightly below the threshold at around 17% mass moisture content.

Furthermore, an additional evaluation was carried out using the method according to WTA 6-8:

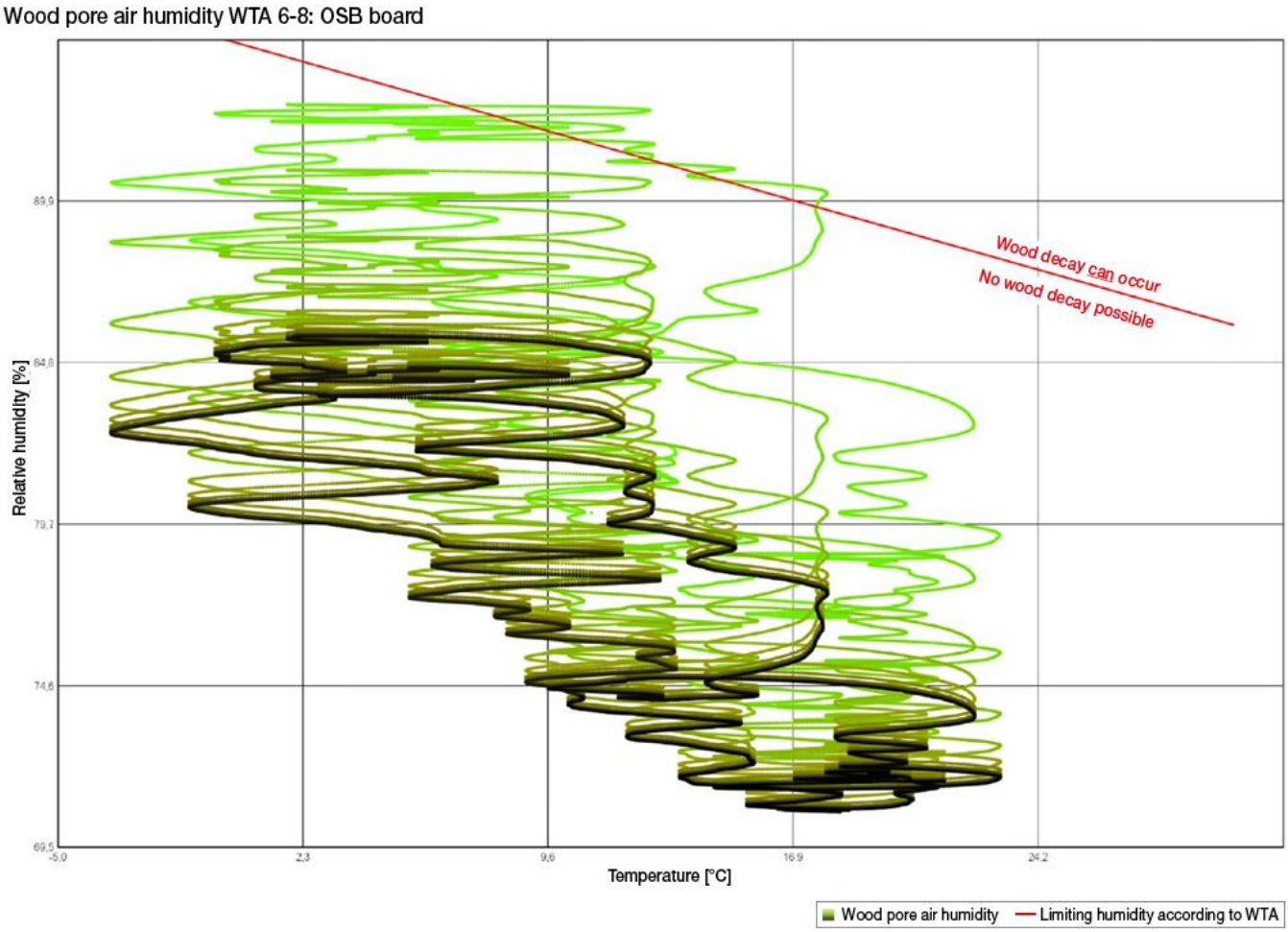
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Evaluation of Wood Moisture Content according to WTA 6-8

The evaluation of wood moisture content according to WTA guideline 6-8 considers the effect of wood moisture on the risk of growth of wood-destroying fungi depending on the prevailing temperature. This is based on research findings by Finnish building physicist Viitanen: the lower the temperature, the higher moisture levels "tolerated" by the wood, and vice versa. A suitable comparison for better understanding can be made with an open yogurt cup: if it is left on the windowsill in summer, mold will form within 2-3 days. If the same yogurt cup is left open in the refrigerator, it takes 2-3 weeks for it to start molding. This behavior can be applied to wood-destroying fungi.

The evaluation graph according to WTA 6-8 does not refer to wood moisture content in mass percentage but to the relative moisture content in the wood pores. The relative humidity is plotted on the diagram against the temperature. Each pair of temperature and humidity represents a state point. The color represents the temporal evolution as the third dimension: from light green at the beginning of the simulation to brown and finally black at the end of the simulation:

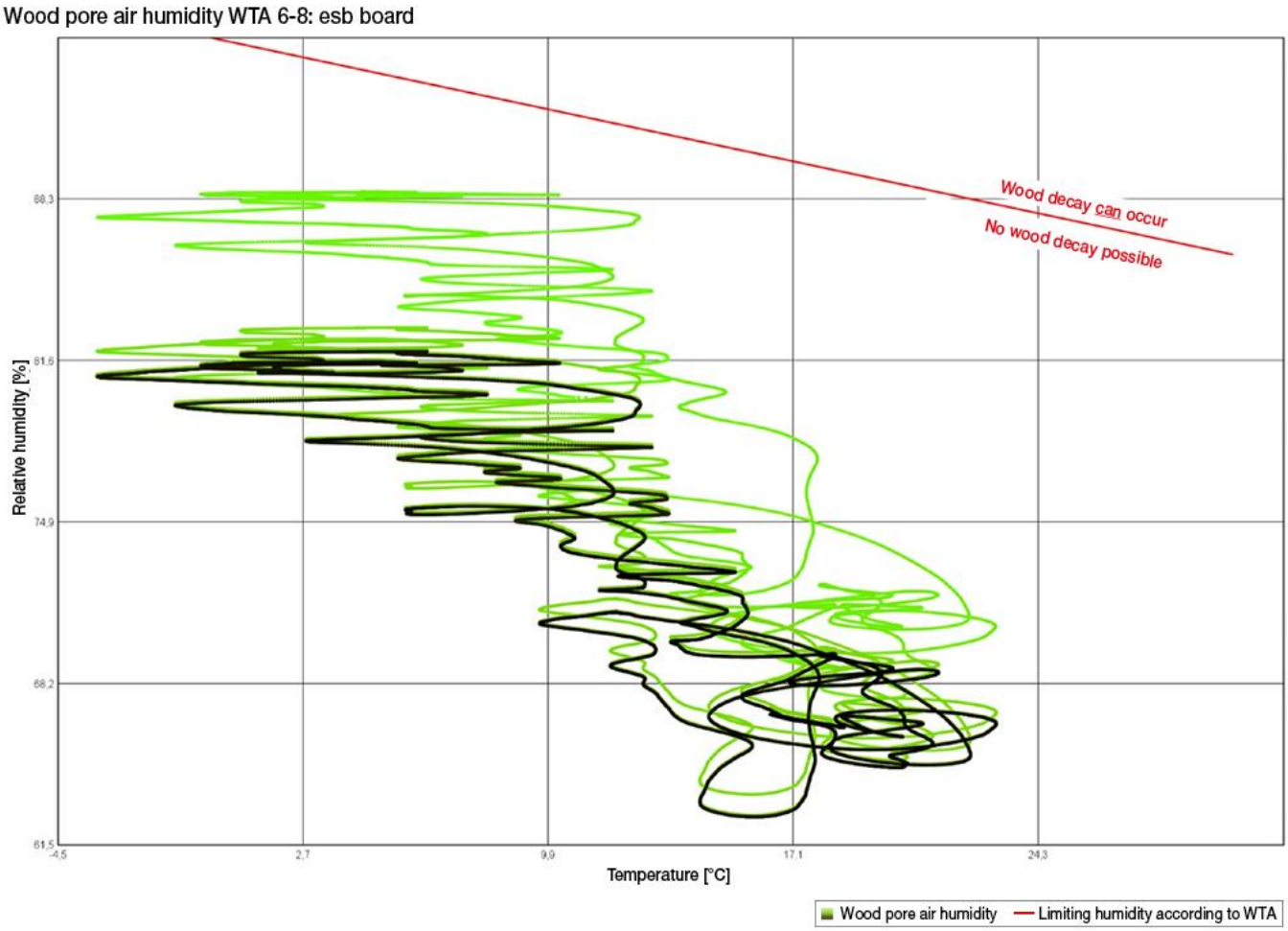
OSB board:



The state points in the first years after installation are slightly above the limit at which wood degradation can occur (not necessarily). However, subsequently, all points are below the red threshold line.

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Esb board:



In comparison to the OSB board, this evaluation also yields significantly better results. The state points are consistently well below the threshold where wood degradation can occur.

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Summary and Recommendation

The evaluations have shown that the diffusion-open esb board behaves significantly more favorably compared to the variant with the OSB board.
The overall construction accumulates noticeably less moisture with the "elka-strong board."

When evaluating the load-distributing layer itself, it is also evident that the OSB board has a significantly higher moisture content and, unlike the esb board, can potentially support wood-destroying fungi in the worst case scenario.

From a building physics perspective, the variant with the esb board is more resilient in the long term and preferable to the OSB board.

Apendix

WUFI output

Sawn timber and wood-based materials in perfection – since 1906



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