Heat Treated Beech Veneer Plywood: Durability Against Wood Destroying Fungi using Accelerated Tests and Mechanical Analysis

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ABSTRACT

Beech (*Fagus sylvatica* L.) veneers were heat treated to three different levels: Light, Middle and Dark. Plywood made from the modified veneers was tested for biological resistance against four wood destroying basidiomycetes: three brown rot fungi and one white rot fungus. Natural beech ("Beech Natural") and plywood ("Plywood Natural") were used as controls. Biological tests to determine mass losses were done according to ENV 12038; mechanical tests for strength losses used the Dynstat method. Results showed that modification of beech veneers by heat treatment improves plywood durability. The classification of these new products into use classes according to EN 350 and EN 460 is discussed.

INTRODUCTION

In this paper we present the results of diploma student Imanuel Issleib of the University of Applied Sciences Eberswalde. He began his research in the laboratory of wood biology, studying the behaviour of different plywood with regard to wood destroying fungi.

We report here a positive effect of heat treatment of beech veneers used to manufacture plywood. Resistance to wood-destroying fungi was measured using two different laboratory test methods. This research was supported by the company OWI in Lohr, Germany, which desires to manufacture wood products for outdoor uses without soil contact. This means the manufactured products must meet the hazard requirements of use class 3.

CEN/TS 1099 provide guidance for biological durability and assessment of plywood in different use classes. CEN/TS 1099 specify that the durability class of the wood species used to produce plywood has the same durability class as the native wood. In the case of beech, having the durability class 5, beech plywood would also have the same durability class.

As a result of our research using thermally modified plywood veneers, we classified the plywood variants according to EN 350-1 in different use classes.

MATERIAL AND METHODS

Material

Plywood produced by OWI GmbH, seen in Figure 1, was used in the bioassays.

Figure 1: Tested Plywood (Left to right):
Natural ("Native") and thermally modified Bright, Middle, and Dark

The test materials were natural plywood ("Native Plywood") and three plywood variants named for their respective discolorations after heat treatment: Bright, Middle and Dark. Native beech without any modification was used as a reference.

Leaching before the biological test

All test specimens were leached with water for 24 hours before exposure to wood decay fungi.
Two treatments remained unleached and were named "Plywood Natural" without leaching and "Plywood Middle" without leaching.

Test fungi

Three brown rot fungi and one white rot fungus were used for determining the biological resistance of heat treated plywood. Test specimens inoculated with these fungi are shown in Figure 2.

Figure 2: Test fungi (Left to right):
Coniophora puteana, Oligoporus placenta, Gloeophyllum trabeum, Trametes versicolor

Test methods

Tests were conducted according to ENV 12038, "Durability of wood and wood-based products. Wood-based panels. Method of test for determining the resistance against wood-destroying basidiomycetes". In this method, two replicates according to EN 113 are incubated in a Kolle flask for 16 weeks. Additionally, we used TGL 12698, in which 5 smaller test specimens are incubated in Petri dishes for 8 weeks. Mass loss was determined after expiration of the test periods. In addition, bending strength losses were measured using the Dynstat machine (Figure 3), according to TGL 12698.

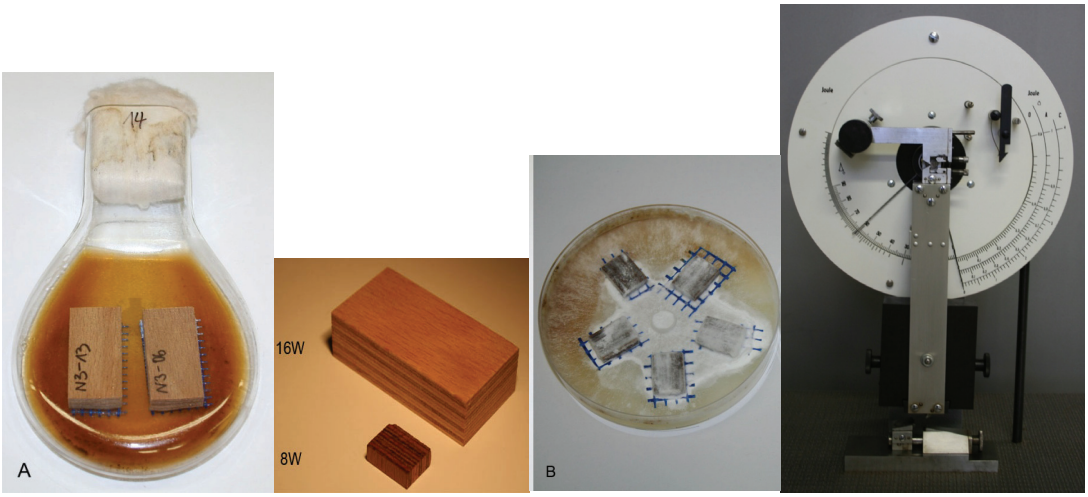

Figure 3: Test methods (Left to right):
Kolle flask Size of specimens Petri dishes Dynstat machine

RESULTS AND DISCUSSION

Mass and strength losses

The mass loss of the plywood specimens following exposure to basidiomycete fungi is the most important parameter for determining biological resistance of these materials. As a guide, a mass loss less than 3% indicates a highly durable material.
Another assessment is to calculate the DSI (Decay Susceptibility Index) - an index of the material's resistance to decay in comparison to reference specimens of Native Beech. A DSI value less than 100 means that the heat-treated plywood is more resistance to decay than the reference Native Beech.

Results with *C. puteana* according to the ENV 12038 method showed the variant Plywood Middle had a mean (30 specimens) mass loss of 3.15% compared with a mean (6 specimens) mass loss of 31.96% for the reference Beech Native. Heat treatment clearly increased the resistance to decay and reduced associated mass loss.
For *C. puteana*, if the DSI value for Beech Native is 100, than the DSI value for Plywood Middle is 9.9.
Without leaching, the Plywood Middle exposed to *C. puteana* had a mass loss of 1.47%. This indicates that a leaching procedure prior to the biological tests is necessary to get "real life" results.

An examination of mass losses with all plywood variants exposed to the four basiomycetes clearly shows that heat treatment reduces mass loss compared to the reference Beech "Native". *C. puteana* was biologically very active, but the most virulent fungus was *G. trabeum.* As expected*, O. placenta* also showed a high level of activity.
Results obtained using Kolle flask and Petri dish exposures were similar.
The Dynstat strength testing device indicated a high degree of correlation between fungal decay (as measured by mass loss) and bending strength loss.

ASSESSMENT OF THE BIOLOGICAL TEST

Classification into durability classes

Results of the biological tests showed that the heat treated plywood variants have mass losses greater than 3%. For this reason, we also determined the DSI (Decay Susceptibility Index) values. According to EN 350-1 and CEN/ TS 15083-1, there are 5 durability classes.
For the reference Beech "Native," the durability class is 5 as is well known. All heat treated plywood variants could be classified into durability class 3. These results are common to the 4 fungi involved in this work. The plywood variant without any heat treatment could be placed into class 4 (especially using the fungus *O. placenta).*

According to EN 460 ("Durability of wood and wood-based products - Natural durability of solid wood - Guide to the durability requirements for wood to be used in hazard classes"), all heat treated plywood variants used in our tests could be classified in use class 3. The results of the Plywood "Middle" was quite good indicating that Plywood "Middle" can be applied in the outdoors without ground contact.

Our results indicate that thermally treated plywood could be a favourable alternative to tropical wood or chemically impregnated wood and wood products. Thermally treated plywood offers limitless opportunities for the creative imagination, for example, through flexible shaping and other machining practices.

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