M.Sc. Wood Technology Master Thesis

Development of a new glass wool insulation material based on natural tannin adhesive

Abstract

Insulation provides energy conservation, thus less greenhouse gas emissions, and better living comfort. In recent years the emphasis has been put on the health issues that come along with formaldehyde, typically used in the production of glass wool insulation. The goal of the thesis was to develop more sustainable and healthier glass wool insulation, with comparable properties to the existing products of Sager AG, and decreased formaldehyde emissions, by substitution of fosil-based adhesive, phenol formaldehyde with tannin-based adhesive. The development of the equipment and procedure for the lab-scale production of boards, as well as the development and validation of testing methods, was a part of this thesis. Three reference adhesives and two new tannin hexamine adhesives have been used for boards production. The boards were submitted to different tests. Results showed that the lab-scale boards have comparable properties to commercial ones. In some of the boards made with tannin-based adhesives improvement in fire performance was noticed. Boards produced with tannin hexamine adhesives had a higher level of emissions than others. In conclusion, boards were successfully developed and are suitable for the line production process.

Experimental

The first part of this work was to develop the equipment and procedure for the lab-scale production of the boards, that can imitate in the best possible way the conditions on the line production (Figure 1, up). Following, five adhesive formulations have been chosen for the lab-scale production and tests: phenol formaldehyde and eco-adhesive, already in use in Sager AG, quebracho formaldehyde, quebracho hexamine and spruce hexamine. Adhesives were used in production of lab-scale boards with targeted densities of 40 kg/m^3. Boards were observed under the microscope, to examine the adhesive distribution quality. Following, the boards were submitted to standard tests: dimensional stability, fire performance, thermal conductivity, and emissions test. Two test methods developed and validated in the course of this work were used as well, long-term recovery and tensile strength tests (Figure 1, down).

Figure 1. Part of the equipment for lab-scale production (up) and long-term recovery test (down)

Results

Results showed that adhesive distribution on lab-scale produced boards was good. Boards made on the lab-scale have comparable properties to the company produced-boards, such as long-term recovery rate, which was over 99% for all tested samples. For the dimensional stability test on 70 ˚C with no humidity regulation, all the samples met the requirements of the relative dimensional change below 1%, in all directions. Thermal conductivity was under 35 mW/(mK) for all the boards. Fire performance was improved in some of the boards made with tannin-based adhesives. The tensile strength of the boards produced with tannin-based adhesives was found to be close to the strength of eco-adhesive boards, that are already in the production in Sager AG (Figure 2). Emission test failed the expectations since the boards produced with tannin hexamine adhesive formulations had a higher level of emissions than other boards.

Conclusion

In the course of this thesis, equipment for lab-scale production of glass wool insulation was developed and production procedure was established. Glass wool bonded with tannin adhesive was successfully produced on the lab-scale. Six out of seven targeted properties were achieved in the new material. Therefore, the boards are suitable for the line production process. A further modification of adhesives in order to reduce emissions and the adjustment of drying conditions will enable boards with tannin adhesives to enter the industrial trial phase.

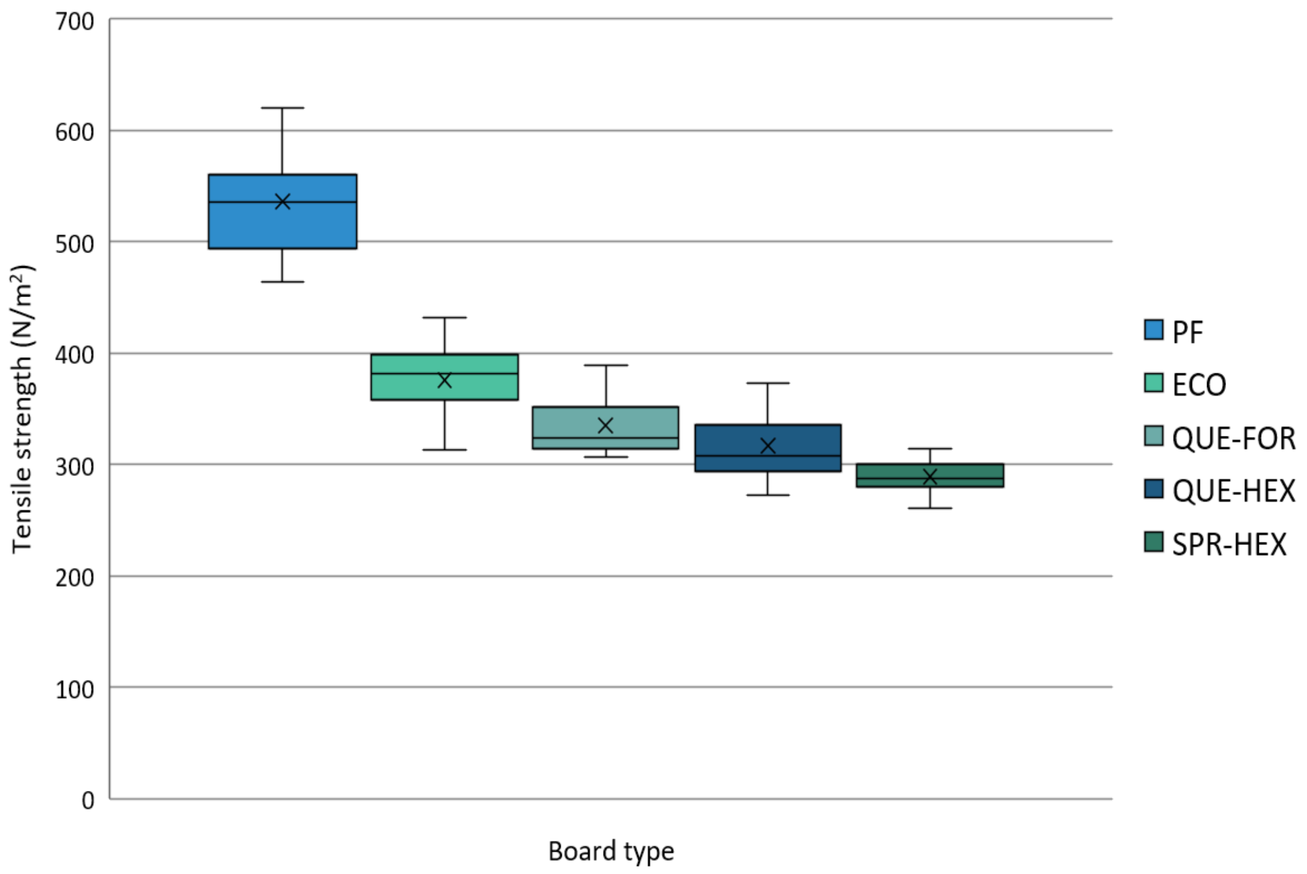

Figure 2. Results from the tensile strength test, n=16, for different adhesive systems

Author
Ema Gajic

Number
MHT/MPI/MA/069/19/01

Embargo Period
1 Year

Bern University of Applied Sciences

Architecture, Wood and Civil Engineering

Solothurnstrasse 102 | CH-2500 Biel 6
bfh.ch | mht.ahb@bfh.ch