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Shape stability of THM-processed laminated veneer products glued with bio-based adhesive systems

Lars Blomqvist[1], Jimmy Johansson[2], Dick Sandberg[3]

[1]PhD student, Linnaeus University, SE-351 95 VÄXJÖ, Sweden
[2]Assistant Professor, Linnaeus University
[3]Professor of Forest Products, Linnaeus University
e-mail: lars.blomqvist@lnu.se

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There are several methods of producing laminated wood such as laminated veneers or boards for structural purposes, plane and cross-wise laminated veneers (i.e., plywood), continuous laminated shapes, and veneers that are shaped and laminated against a mould (essentially for furniture and interior purposes) (*1*). This paper is about the shape stability of plane and cross-wise laminated veneers that are glued with bio-based adhesives.

Increasing environmental concerns and the rising cost of petroleum-based (synthetic) adhesives has made bio-based adhesives of interest. Some bio-based adhesives, such as tannin and lignin, can be extracted from wood itself. Tannins are more reactive than many other adhesives, including phenol, but it is also more expensive. Tannin has been used as an adhesive for wood composite production, such as particleboard and medium density fibre board production as well as laminate and finger joint bonding. Lignin is available in large quantities from the pulp industry, because it is a by-product of the industry's processes. Lignin is less expensive than tannin, but it is not as reactive as tannin. Nevertheless, the lignosulfonates that come from the sulfite pulping of wood have been found to be more reactive than lignin (*2*). Research shows that it is possible to bond veneers together with bio-based adhesive in the form of lignosulfonates and tannin-type compounds (*3*). A drawback of many bio-based adhesives is their low reactivity during hardening, resulting in long pressing times or the need for elevated temperatures. High pressures and temperatures change the conditions of the THM process and thus increase the risk of unacceptable distortion or cracking.

The aim of the present work was to investigate the shape stability of THM-processed laminated veneer products glued with three bio-based adhesive systems: lignin, tannin, or a mixture of lignin and tannin.

Three veneers were bonded together into a flat construction with the middle veneer oriented crosswise. The basic demands of the laminate were that it would be shape stable and useful in climates with high humidity without delaminating in the bond line. The strength of the bond line was not tested in this work. Quarter-sawn veneers of Scotch pine (*Pinus silvestris* L.) with a size of 150x150x2.6 mm were used. The veneers were conditioned at a relative humidity (RH) of 20 % and a temperature of 20 °C. The veneers' thicknesses were made uniform by sanding. Used veneers have straight fibres. Lignosulfonates (Borregaard LignoTech, Norway) and tannin (Kremer Pigmente, Germany) were tested, and a urea formaldehyde adhesive (Casco Adhesives Inc., Sweden) was used as a reference. Three groups with bio-based adhesive were tested: lignosulfonates, tannin, and a mixture of lignosulfonates and tannin. All three had a glue spread of approximately 129 g/m2. The glue spread of the reference was 170 g/m2.

The pressing were applied by a press with press plates that underwent resistive heating. The contact pressure was 0.5 MPa, and the temperature and the pressing time varied. The shape of the individual samples and the condition of the bond line were determined immediately after pressing and at different phases of RH cycling.

The results from the investigation show that it is possible to bond veneers together with bio-based adhesive in the form of lignosulfonates and tannin-type compounds to form a stable laminated veneer product. Future studies can refine the time and temperature for optimum bonding.

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