Is it possible to constrain moisture movement of densified wood product mechanically?

Girma Kifetew, Jonaz Nilsson and Dick Sandberg
Linneaus University
School of Engineering
SE-351 95 VÄXJÖ
girma.kifetew@lnu.se
jonaz.nilsson@lnu.se
dick.sandberg@lnu.se

Key words: densification, shape stability, EWP.

Abstract

A modified softwood product would enable utilization of softwood in areas, where today fails to accomplish. Densification is one of the oldest wood modification methods that have been used to improve some wood properties. Compressing wood in the transverse direction will reduce the void volume of the lumens in the wood material and increase its density. This process is commonly called densification. Already in 1886, the idea of densifying wood by compressing it in the radial direction was understood [1]. Hence, this study presents an attempt made in developing a novel wood composite product for use in structural applications. The aim of wood densification is to compress solid wood product without causing “damage” in the cell walls. The goal is to improve wood properties desired for specific applications like hardness and abrasion resistance. One of the major problems with densified wood however is the ability of the product to retain its original dimension under the influence of moisture. There have been many studies relating to stabilization of moisture movement of densified wood by using various treatments. This includes chemical treatments as well as heat and steaming processes. To prevent the formed wood from returning to its initial form, the following procedures are available: 1) Chemical modification by de-activation of the OH-sites by acetylation (substitution of the -OH by CH3COO-groups), or formaldehydation (fixing of H2CO between two hydroxyls to obtain a strong chemical bond), etc. 2) Thermo-Hydro-Mechanical treatment, i.e. the use of temperature, moisture and mechanical action. 3) Hydrolysis of hemicelluloses under the effect of water and high temperature in order to relax the internal stresses. 4) Mechanical fixing by gluing, nailing, screwing, etc. [2]. However, the chemical methods that have been used (1-3 above) have also some drawbacks. Therefore, the principal goal of this study was to investigate the effect of mechanically moisture movement stabilization method.

This study primarily utilizes a simple solid wood densification method. The technique is based on compressing a clear solid softwood piece with vertical annual rings in the radial direction by restraining the tangential expansion. Further, three-layered cross laminated composite product was manufactured by utilizing the densified wood as a service layer. Moreover, the service layer maintains a harmonious pattern and emphasises the esthetical property of the modified product. In order to manufacture a 3-layered cross laminated composite; 4 mm thick densified wood panels with a size of 500 by 500 mm² were prepared. These panels were used as the service layer of the cross laminated composite. The unmodified middle and bottom layer panels were also prepared of radially sawn wood without defects such as knots. Thus, the cross laminated composite consists of 4 mm thick densified service layer and 6 mm thick middle layer. However, the bottom layer was prepared with three different thicknesses i.e. 2 mm, 4 mm and 6 mm. As a result, three groups of modified cross laminated composite with four samples in each group were manufactured. Finally, a total of 12 square shaped cross laminated samples with a size of 500 by 500 mm² were manufactured and examined. The adhesive used for gluing
piece together in to panels was polyvinyl acetate (PVAc). While, for manufacturing of the laminated composites polyurethane glue was used. Finally, the cross laminated composite was subjected to climate variations in order to investigate the shape stability. For that reason, an extensive cupping data of the cross laminated composite were collected during a period one year at varying relative humidity conditions, Figure. As a result, the influence of service to bottom layer thickness ratio on the degree of moisture induced cupping is remarkably noticeable. Moreover, an appreciable shape stability of the cross laminated composite is recorded by increasing the service to bottom layer thickness ratio and when the service to bottom layer thickness ratio was about 2 the 3-layered cross laminated composite was form-stable.

Figure 1: Setup of cupping measurement on the service layer of the 3-layered cross laminated composite.

The result of this study reveals the significance of service to bottom layer thickness ratio on the shape stability of the cross laminated composite. Consequently, the performance and the shape stability of the cross laminated composite were significant when the service to bottom layer thickness ratio increases. Therefore, it appears feasible to disclose the appreciable degree of shape stability, hardness and wear resistance of the product. Accordingly, cross laminated composite can be considered as one of the promising mechanical methods for improving moisture movement of densified wood product. It will also in some cases make it possible to modify softwood products without chemical or thermal treatments.

References