Analysis of Adhesive Joint Using Beech Wood

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INTRODUCTION

Wood is an anisotropic, porous material with key features like longitudinal tracheids in softwoods and vessel elements in hardwoods, facilitating resin flow. Glue is the primary bonding material in wood products, with adhesives classified as organic, semi-synthetic, or synthetic.

MATERIAL & METHODS

Samples were prepared with two compression times (60 min, 120 min) and three wood ring orientations: radial-radial (RR), radial-tangential (RT), and tangential-tangential (TT). Polyurethane glue (PUR) was used. The samples were exposed to UV radiation and moisture for 3 months.

The shear strength (EN302) and microstructure (by optical microscope, SEM, EDS, FTIR, XRD, and epi-fluorescence microscopy) were analyzed.

PENETRATION DEPTH (t = 0)

Table 1: Adhesive joint thickness and depth of penetration of the adhesive into the wood microstructure (annual rings orientation: RR, TT)

	RR		TT	
	60 min	120 min	60 min	120 min
Adhesive joint thickness [µm]	128.2	75.8	97.2	45.6
Penetration into the bottom plate [µm]	339.8	37.9	324.5	85.5
Penetration into the upper plate [µm]	25.8	478.6	77.9	110.2

Table 2: Adhesive joint depth of penetration of the adhesive into the wood microstructure by area by plates (annual rings orientation: RR, TT)

Orientation	A(P1) [%]	A(P2) [%]
RR	70,17	29,83
TT	38,72	61,28

	RT		
	60 min	120 min	A(P1) [%]
Adhesive joint thickness [µm]	253.9	8.3	/
Penetration into R orientated plate [µm]	22.9	299.2	84.38
Penetration into T orientated plate [µm]	89.6	140.4	15.62

Table 3: Adhesive joint depth of penetration of the adhesive into the wood microstructure by distance and by area by plates (annual rings orientation: RT)

RESULTS

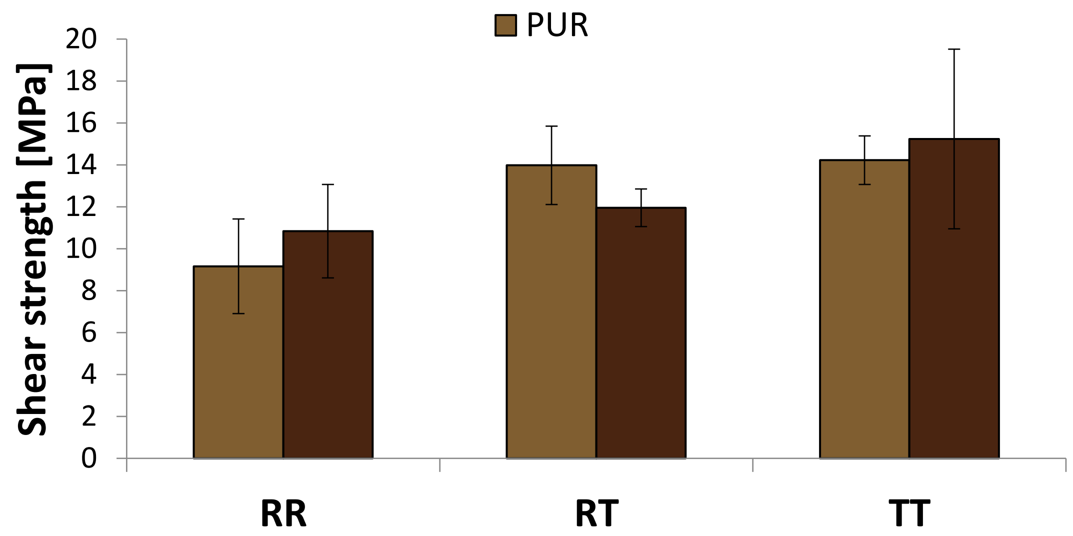

Figure 1: Shear strength results

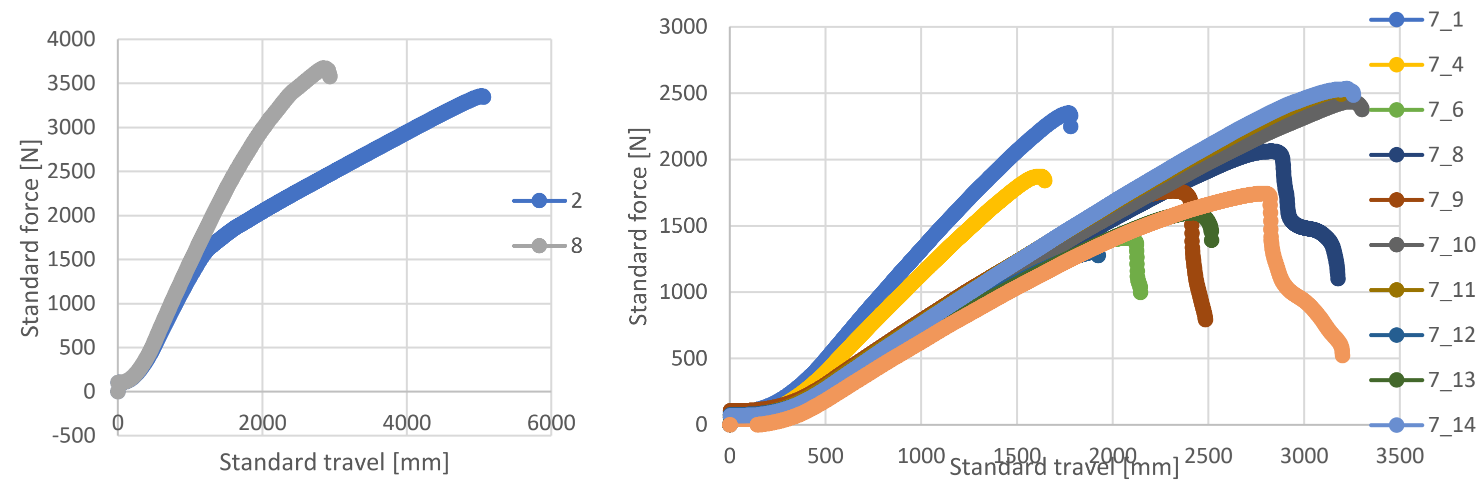

Figure 2: Tensile-shear test results for the samples before and after aging (1 month)

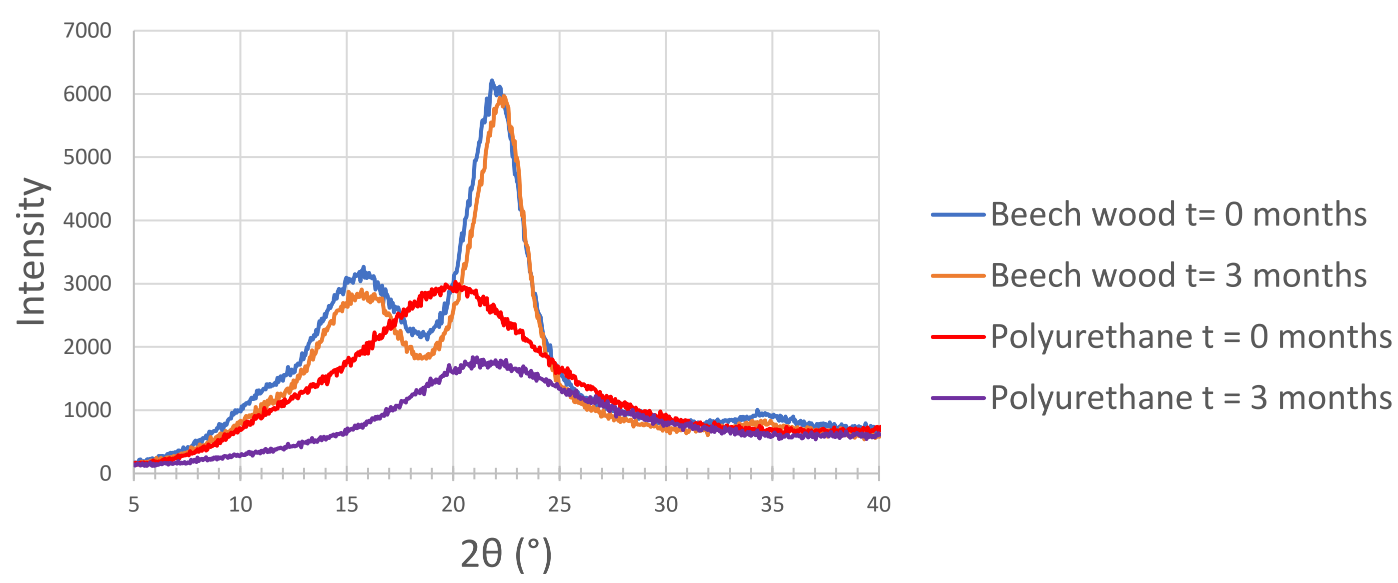

Figure 3: XRD results for beech wood and polyurethane glue analysis before and after aging

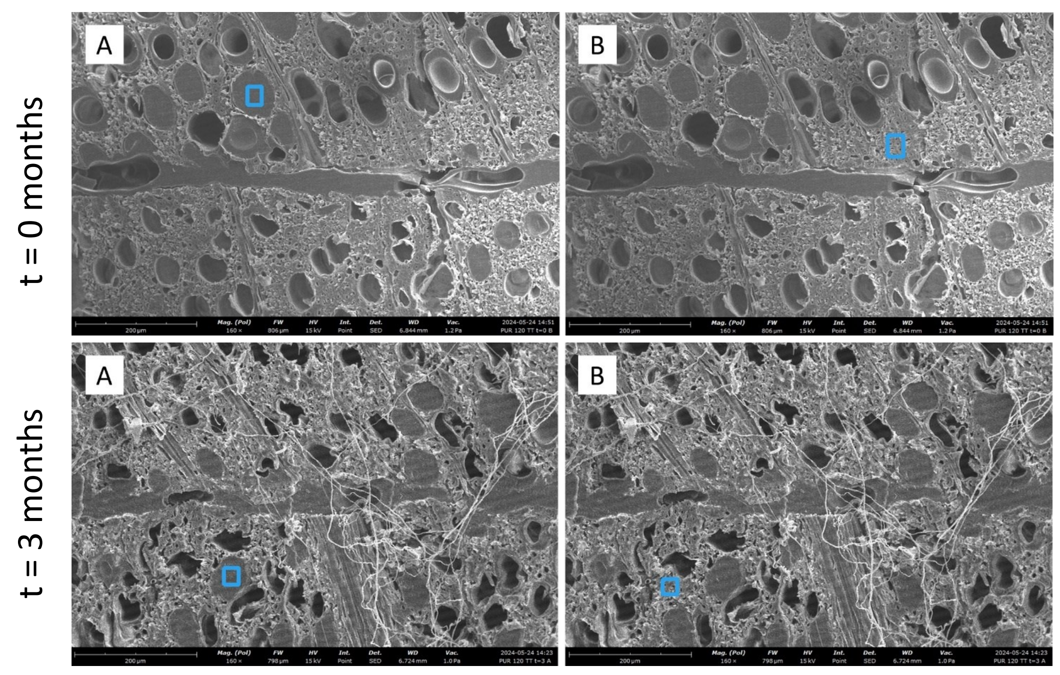

Figure 4: SEM image of a sample PUR 120 TT (time of aging: 0 and 3 months, A – polyurethane glue, B – beech wood)

CONCLUSION

This study focuses on the aging process of wood joints, essential for understanding the durability of wooden structures. We investigated how environmental factors like moisture, temperature changes, and mechanical stress affect wood over time. Our results showed that samples compressed for 120 minutes with radial-tangential (RT) orientation had the best penetration. To fully assess aging effects, prolonged exposure is necessary, as both wood and polyurethane glue degrade over time. Identifying weaknesses through this research supports the development of stronger joint designs and the selection of more resilient materials, enhancing the longevity of wooden constructions.