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Shape stability of laminated timber

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Abstract: *Shape stability of laminated timber.* The quality of laminated products depends on several factors - material, technology, process of layering, etc. In this work we focused on the influence of thickness of the layer, the number of layers, and bending radius on shape stability of laminated timber.

When compared with solid wood, laminated timber achieves better shape stability.

Keywords: aspen, laminated wood, shape stability, shaped moulding, shaping form, bending radius, dimensional deviation

INTRODUCTION

Wood is a material of native matter whose properties are given by botany species, conditions at growing, and interventions at cultivating. In certain range, the properties are not able to be influenced; they reflect natural process with limited possibilities to influence the result of the process – product quality (quality of wood raw material) [1].

Fast-growing wood species are little utilized in industry. That is why we decided to research possibilities of processing of aspen wood (*Populus tremuloides)* at production of furniture parts. We choose waste-free technology of laminating. Lamination is a technology process when the properties are changed by gluing of thin wood materials; and various products are made – at furniture production mainly shaped laminated parts[2].

One of the purposes of lamination process is to achieve shape stability of a furniture part i.e. constancy of its shape.

In the paper we aimed at research of the influence of lamella thickness, the number of layers, and bending radius on the shape stability of laminated wood.

Material and methods

In the experiments, we used material made from aspen wood. We used lamellas with thickness of 10, 8.3, 5, and 2 mm; we applied an adhesive on one side of them. We used polyurethane adhesive Jowat-Power PUR® 687.40 in the amount of 120 $g.m^{-2}$ and urea-formaldehyde adhesive DIAKOL M (UF adhesive) in amount of 190 $g.m^{-2}$. Laminated set was composed of 2, 3, and 5 layers of lamellas laid along the fibre in longitudinal direction (fig. 1).

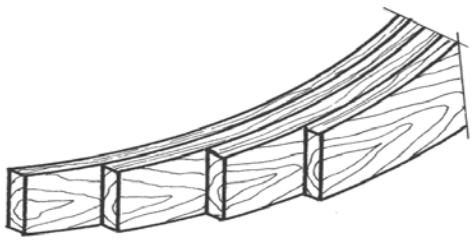

Fig. 1 Arrangement of lamellas in laminated wood

Shaping of laminated set by bending process was done in one-cycle (gluing, bending, and stabilisation simultaneously). We choose two radiuses of shaping form R = 150 and 200 mm.

Stabilisation was done by resistive heating at pressing at temperature of 70 °C and time of 60 minutes. After removal from the press – pressure stabilisation, we measured shape

stability of laminated moulding at time intervals of 2 min., 20 min., 40 min., 1 hour, 2, 3, 4, 8, 16, 24, and 48 hours.

To determine the shape stability, we used specimens with dimensions of 80 x 25 x 1100 mm.

Wood moisture content of lamellas at gluing with polyurethane adhesive was w = 25% and with UF adhesive w = 7%.

Shape stability was estimated according to deviations in curve radius of laminated moulding during the study period. At studying of shape stability of mouldings shaped in "U", two types of shape changing can occur. Either the moulding will be closing or opening; i.e. moulding arms will be closing in each other or drawing apart. In the first case, value of R will lower by negative deviation (-Δr) and in the second case it will increase by positive deviation (fig. 2).

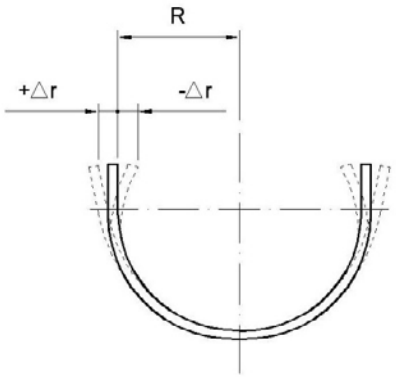

Fig. 2 Schematic description of deforming (closing, opening) of laminated part shaped in "U"

RESULTS AND DISCUSION

Based on our results and the papers by other authors *(Sarvaš 2011, Suchý 2004, Giertlová 2004),* we can state that there exist some differences in shape stability of laminated wood.

Shape stability of our specimens of laminated wood was influenced by the layers thickness, the number of them, bending radius, and by the adhesive. It is confirmed by data in table 1.

From the measurements that has been carried out results that at all the mouldings, the most intensive shape changes are in progress during four hours after removing from the press. Immediately after removing, the shape change – change of moulding radius is growing. Studied U shape was opening or closing. Shape instability was deteriorating when layer thickness of laminated moulding was increasing. At the thickness of 10 mm the shape stability was the worst. The moulding was opened by 13 mm on each side.

The best shape stability was achieved at 5-layer laminated wood with lamella thickness 5 mm and 2 mm. At mouldings glued with PUR adhesive shaped to bending radius R = 200 mm, medium opening was occurred; and at moulding to radius R = 150 mm medium closing of the moulding was occurred.

Tab. 1 Deviations from radiuses of shaped mouldings of laminated aspen wood

Time of the intervals measurement of the deviations	Bending radius **R** [mm]				
	200	200	200	150	200
	Thickness of layer **h** [mm]				
	10	8,3	5	5	2
	Number of layers				
	2	3	5	5	5
	Deviations from radiuses ± **Δ r** [mm]				
2 min	12,72	5,51	2,43	0,38	-2,39
20 min	12,56	5,54	1,87	0,17	-3,07
40 min	12,47	5,44	2,34	0,33	-3,42
1 hour	12,27	5,07	2,20	-1,11	-3,55
2 hour	12,52	5,04	2,35	-1,78	-3,55
3 hour	12,93	5,15	2,21	-1,16	-3,26
4 hour	12,57	5,10	2,77	-0,62	-2,63
8 hour	12,40	5,52	2,85	-1,42	-2,72
16 hour	12,50	6,01	2,89	-1,30	-2,84
24 hour	12,42	5,56	3,34	-1,52	-2,70
48 hour	12,43	5,75	3,10	-1,52	-2,69
Glue	PUR	PUR	PUR	PUR	UF

Also 5-layer moulding, glued with UF adhesive and with layer thickness of 2 mm, was closing. The deviation was a little higher than at mouldings glued with PUR adhesive.

Final – stabilised shape of mouldings was achieved at all the measured specimens after 24 hours. In no case the shape of a moulding went back to initial value of radius of shaping form. The deviation from radius of shaping form was 1 ÷ 6%.

CONCLUSION

In our experiments we researched the shape stability of laminated wood made from aspen wood. We evaluated the influence of lamella thickness, the number of layers, and bending radius on shape stability of laminated wood. Based on the experimental work we can conclude that studied factors influenced the shape stability of laminated wood.

The least opening/closing of laminated moulding i.e. the best stability was showed at 5-layer laminated wood. Laminated mouldings made from two thick layers were the least stabile. Final shape of all the measured mouldings was stabilised by 24 hours. None of the measured mouldings was stabilised into the final dimension – radius of shaping form. The deviation was 1 ÷ 6%.

In final properties of laminated wood was manifested the synergic effect of wood properties, thickness and number of lamellas, and the bending radius.

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Streszczenie: *Stabilność kształtu tarcicy warstwowej*. Jakość materiałów warstwowych zależy od wielu czynników, materiału, technologii, procesu składania itp. W pracy skupiono się nad wpływem grubości warstwy, ilości warstw i promienia zgięcia na stabilność kształtu tarcicy warstwowej. W porównaniu do drewna naturalnego, tarcica warstwowa osiąga lepszą stabilność.

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