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# Effect of mechanical modification of wood veneers on their planar formability

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**Abstract:** *Effect mechanical modification wood veneers on their planar formability.*The aim of paper is the proposal mechanical modifications of veneers and its impact on their formability. Formability of veneers was determined under load of buckling and four-point bending. Mechanical modification was implemented in two methods, a method creating notches and method of embossed. Measurements were made on beech and birch veneers of a thickness 0.55 mm. On the basis of preliminary tests were selected geometric shapes suitable modification. Formability of modified veneers was evaluated for their effects of load. The most appropriate way of modification, which increases formability of wood veneers, is the method embossed in the shape of a regular grid at an angle of 45° to the fibres.

*Key words:* wood veneer, 2D moulding, mechanical modification

## INTRODUCTION

Currently, the surfaces of many products are with slim wooden layers (veneers), which would guarantee them a natural look. In such cases, is required that the veneer have the best formability. The radius of curvature of the veneer should be the smallest. With this approach we encounter also in furniture construction.

Furniture constructions are often produced as stereotomic. These structures are formed into various curves and curved planar and spatial surfaces. This furniture most often produced from plastic, but we have focused on natural materials - wood. For wood, as anisotropic material, it is important to examine the changes in shape and damage in its planar and spatial forming. Inasmuch as, that some stereotomic construction are formed by surfaces, in our study, we focused on surface elements - veneers.

The problem of forming veneers is interesting both technologically and economically. According to Möller, using curved surfaces is expected saving of material in terms of its thickness. The authors Wagenführ, Buchelt, Pfriem (2005) investigated the effect of veneer thickness and size of the bending load on the size of the bending radius and deformations, compared with deformations in three-dimensional forming. One of the objectives of this research, as well as our research is to determine the minimum radius of curvature, which is suitable for veneers sheathing.

The aim of this work is to propose a method of mechanical treatment veneers to improve its formability when they are burdened with a four-point bending and buckling in the plane. The aim of the methodology for testing mechanically modified veneers is to determine the amount of the minimum radius of curvature. For comparison and evaluation results will serve untreated reference samples.

## MATERIALS AND METHODS

The test samples were made of veneer birch *(Betula verrucosa)* and beech *(Fagus sylvatica),* thickness of 0.55 mm. Dimensions of test specimens: width 14 mm, length 100 mm. The test pieces were conditioned at 12% humidity. The size of the grid i.e. the length of the cuts in each case was 1.5 mm. Tests shall be carried on radial and tangential veneers (fig.

1). Number of test pieces for each modification is fifteen. The test results of modified veneers were compared with mechanically untreated veneer.

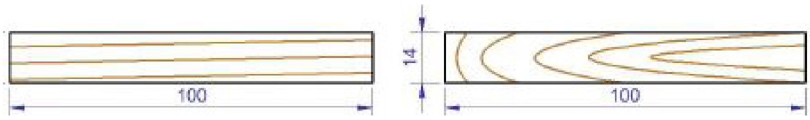


**Fig. 1. Test specimens - the shape, size and direction of the fibers**

First to be conducted preliminary tests which to determine the most suitable method of mechanical modifications of veneer. It was a different combination of "regular liner patterns" (fig. 2) that has been applied by pushing the veneer (embossed) and creating linear cuts.

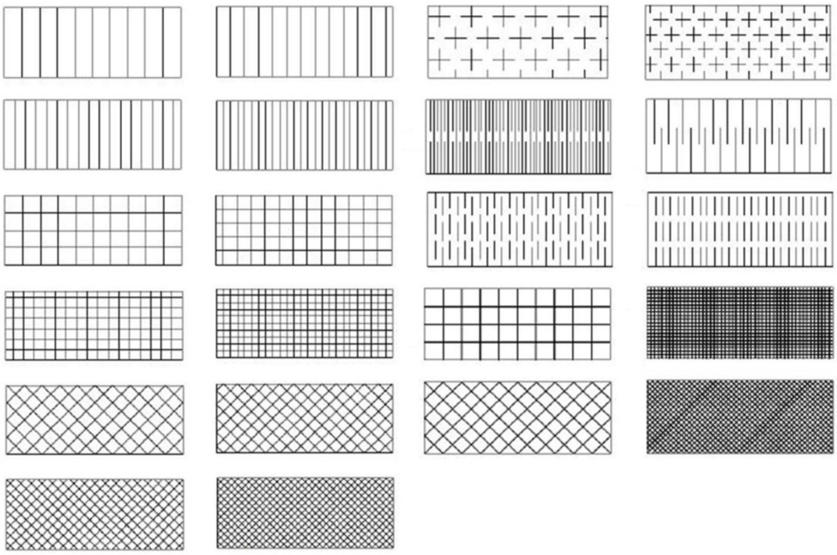

**Fig. 2. Types of mechanical modification - rasters shapes**

After preliminary tests, we selected three alternatives modifications (fig. 3), namely: cutting grid at an angle 45° to fibers, hobbing (embossed) 45° grid at an angle to the fibers, creation of cuts perpendicular to the fibers. The distance between the grid lines is 1.5 mm.

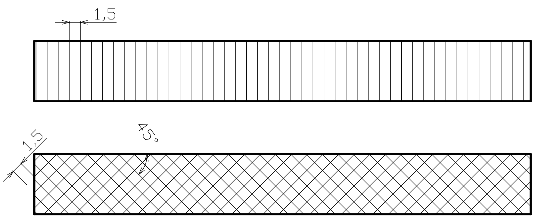


**Fig. 3. Types of mechanical modification chosen by preliminary tests.**

The uniform structure of the grid in the veneer was achieved using a press, where the pressure applied to the sample of 0.9 MPa beech and birch for the sample of 0.75 MPa. To determine the formability modified method we chose buckling load and four-point bending. In both methodologies is investigated radius of curvature the test sample. The values of the radius of curvature of the modified veneers were compared with reference samples which were not mechanically modified.

**Buckling:**

The test scheme and the principle of testing in buckling load is shown in fig. 4.

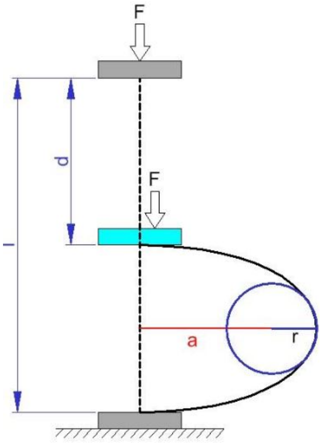


**Fig. 4. The test scheme and the principle of testing in buckling load.**

Such characteristics to determine the impact of modifications on formability veneers we determined the value buckling of the test specimen under buckling load (dimension of deflection) and a minimum radius of curvature determine the relationship shown in fig. 4:

$$r = \frac{(b/2)^2}{a}$$

Where: $= l - d$ ; l – length of the test specimen (mm), d – a path that through the upper jaw (mm), a – the maximum buckling (deflection) of the test specimen (mm)

**Four-point bending:**

The test scheme and the principle of testing in four-point bending is shown in fig. 4.

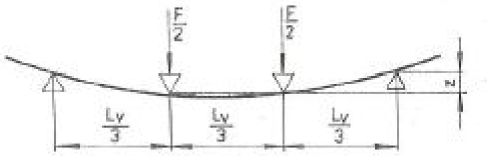

**Fig. 5. The test scheme and the principle of testing in four-point bending**

Such characteristics to determine the impact of mechanical modifications to the formability veneers in four-point bending load, we determine the radius of curvature $R_{min}$ according to the equation:

$$R_{min} = \frac{23 \cdot l^2}{216 \cdot y},$$

where: l – support span (mm), y – the size of deflection (mm):

The second criterion of formability is bendability coefficient, which reflects the ability of a material to change its shape due to bending moment. Bendability coefficient is expressed by the equation: $k_o = h/R_{min}$, where: $R_{min}$ – radius of curvature (mm) and h – veneer thickness (mm).

RESULTS

**Evaluation of test results of buckling:** From the measured and calculated values (table. 1) we can conclude that both methods of mechanical modification significantly influence the formability of veneers.

**Table 1.: Table of measured and calculated values for buckling load.**

| | Birch – radial veneer | | Birch – tangential veneer | | Beech – radial veneer | | Beech – tangential veneer | |
|---|---|---|---|---|---|---|---|---|
| | $R_{min}$ (mm) | $k_o$ | $R_{min}$ (mm) | $k_o$ | $R_{min}$ (mm) | $k_o$ | $R_{min}$ (mm) | $k_o$ |
| **Reference sample** | 4,75 | 0,115 | 19,53 | 0,028 | 7,65 | 0,072 | 10,41 | 0,052 |
| **Cutting grid at an angle 45°** | **2,24** | **0,245** | 12,05 | 0,045 | 6,69 | 0,082 | **4,55** | **0,121** |
| **Embossed grid at an angle 45°** | 2,67 | 0,206 | 8,28 | 0,066 | 6,73 | 0,081 | 4,88 | 0,112 |
| **Cutts perpendicular to the fibers** | 4,43 | 0,124 | 19,39 | 0,028 | 9,58 | 0,057 | 5,89 | 0,093 |

The most suitable methods has proven the formation of the grid at an angle 45° cutting and embossing. Smallest radius of curvature, i.e. formability of best has been achieved in sample of the birch radial cutting the grid at an angle 45° (r = 2.24 mm) as compared to non-modified wood veneers there was an increase of formability about 52.85% (r = 4.75 mm). Beech veneer shows the best formability also in modifying cutting the grid at an angle 45° but in the tangential direction (r = 4.55 mm). Least impact on improving of formability had modification cutting the grid perpendicular to the fibers.

**Evaluation of test results of four-point bending:** In determining the method of formability four-point bending formability was evaluated based on achievement of a minimum radius of curvature $R_{min}$ and coefficient of bendability $k_o$. These values are shown in table 2.

**Table 2.: Table of measured and calculated values for the four-point bending load.**

| | Birch – radial veneer | | Birch – tangential veneer | | Beech – radial veneer | | Beech – tangential veneer | |
|---|---|---|---|---|---|---|---|---|
| | $R_{min}$ (mm) | $k_o$ | $R_{min}$ (mm) | $k_o$ | $R_{min}$ (mm) | $k_o$ | $R_{min}$ (mm) | $k_o$ |
| **Reference sample** | 13,44 | 0,0409 | 15,32 | 0,0359 | 14,64 | 0,0376 | 14,49 | 0,0380 |
| **Cutting grid at an angle 45°** | **9,42** | **0,0584** | 10,07 | 0,0546 | 9,95 | 0,0553 | **9,47** | **0,0581** |
| **Embossed grid at an angle 45°** | 10,36 | 0,0531 | 12,35 | 0,0446 | 11,86 | 0,0464 | 10,73 | 0,0513 |
| **Cutts perpendicular to the fibers** | 11,27 | 0,0488 | 12,49 | 0,044 | 10,81 | 0,0509 | 9,57 | 0,0575 |

Methodology four-point bending confirmed that the best formability veneers is the modification of formation the grid at an angle 45 cutting and the embossed. Smallest radius of curvature, that is best formability has been achieved in the birch radial sample with cutting grid at an angle 45° (r = 9.42 mm) as compared to the non-modified wood veneers there was an increased formability about 42% (r = 13.44 mm). Beech veneer shows the best formability also in the modification cutting grid at an angle 45° but in the tangential direction (r = 9.47 mm). Least impact on improving of formability had modification of cutting grid perpendicular to the fibers.

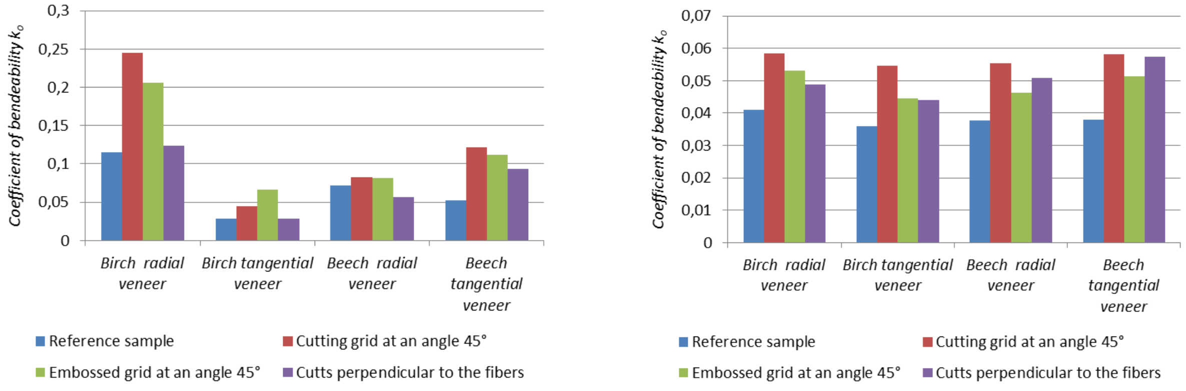


**Fig. 6. Influence of mechanical modifications on the formability veneers, evaluated using the coefficient of bendability**

In both methodologies was confirmed that best formability has been achieved by modifying the cutting grid at an angle 45° (fig. 6). In our opinion for the test specimens small in size and slim is methodology for formability testing using buckling as easier and more precise.

## CONCLUSIONS

The experimental tests show the following conclusions, in view of impact of mechanical modifications on the formability veneers:

- Mechanical modification has a positive effect on the planar formability of veneers. Modification can be done by pushing a profiled preparation (embossed) or cutting the surface of the veneer
- As the most suitable type of modification, the method of cutting grid at an angle 45˚ has been proved; where there was an improvement of formability of birch and beech samples in radial and tangential direction. Other suitable method, from the tested modifications, is modification by embossed grid at an angle 45˚.
- Inappropriate way of modification was the method of cutting veneers perpendicular to the fibres; the beech radial samples showed a deterioration of formability.

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**Streszcznie:** *Wpływ modyfikacji mechanicznej fornirów na ich formowalność planarną.* Prezentowana praca opisuje propozycję mechanicznej modyfikacji forirów i jej wpływ na ich formowalność. Badano dwie metody, nacinanie oraz płaskorzeźbowanie. Nadano forniry bukowe i brzozowe o grubości 0.55 mm. Najlepszą metodą okazało się płaskorzeźbowanie w postaci regularnej siatki pod kątem 45 stopni do przebiegu włókien.

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