

# Effectiveness of Asymmetrical Veneering with Hardwood Species of Varying Shrinkage and Porosity

## Učinkovitost asimetričnog furniranja furnirom tvrdih vrsta drva različitog utezanja i poroznosti

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**ABSTRACT** • *The aim of the study was to check deformations of asymmetrically veneered panels using glue with elastic bonding. In order to achieve the aim, a special stand was designed to analyse the geometry of furniture elements. It is known that boards became convex after veneering with rigid glue. However, the level of deformations for varying parameters of veneering was not equal. As the result of veneering with elastic glue, the boards preserved their primary shape. In any case, the level of deformation depended on wood veneer species. The deformation of the boards was not influenced by their shrinkage. It is supposed that the main influence is the difference in porosity.*

**Keywords:** *asymmetrical veneering, wood-based panels, deformations, shrinkage, porosity*

**SAŽETAK** • *Cilj istraživanja bio je provjeriti deformacije asimetrično furniranih panela primjenom elastičnog ljepila. Da bi se postigao cilj, dizajniran je poseban stalak za analizu geometrije dijelova namještaja. Poznato je da nakon furniranja primjenom krutog ljepila ploče postanu konveksne. Međutim, razina deformacija za različite parametre furniranja nije jednaka. Nakon furniranja primjenom elastičnog ljepila ploče su očuvale svoj primarni oblik. U svakom slučaju, razina deformacije ovisi o vrsti drva furnira. Na deformaciju ploče ne utječe utezanje ploče. Pretpostavlja se da najveći utjecaj na deformacije ploča ima poroznost drva.*

**Ključne riječi:** *asimetrično furniranje, ploče na bazi drva, deformacije, utezanje*

### 1 INTRODUCTION

#### 1. UVOD

Veneering is one of the most important processes in today's furniture industry. The only fully recognised, tried and tested method is symmetrical veneering. In

industry, the process of asymmetrical veneering was applied a long time ago (Hayward, 1949), but now is only used occasionally. On the one hand, it leads to cheaper products and production (Ostrowski and Roszkowski, 2009), but on the other hand, it causes warp of furniture elements. An analysis of deformation is espe-

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cially important when composite materials are taken into consideration (Negri *et al.*, 2009). Asymmetrically veneered wood-based panels, used as furniture elements, are composites consisting of materials of different physical and chemical properties glued together. Therefore, the glue is the key to finding a solution to avoid deformations in the composites.

Industrial asymmetrical veneering is currently done intuitively. Obviously, it would be better if this method was supported with the results of studies. The purpose of the initial experiments was to find an adhesive that would bond veneer and board without causing significant geometric deformations in asymmetrical veneering. In order to achieve it, samples were veneered only on one side using 5 industrial and 1 experimental glue (Oleńska *et al.*, 2010; Oleńska *et al.*, 2011 a,b). The present research showed that samples, asymmetrically veneered using rigid glue bonds, had a general tendency to become deformed. However, the properties of the glue are the most important factor affecting the level of geometric deformations of the board. The main conclusion from the preliminary studies is that it is possible to avoid casting asymmetrically veneered panels by using an elastic bonding adhesive. Therefore, the following research was performed with this type of glue. Primary research showed the importance of shrinkage on asymmetrical veneering (Oleńska *et al.*, 2011c), and therefore extended research was continued.

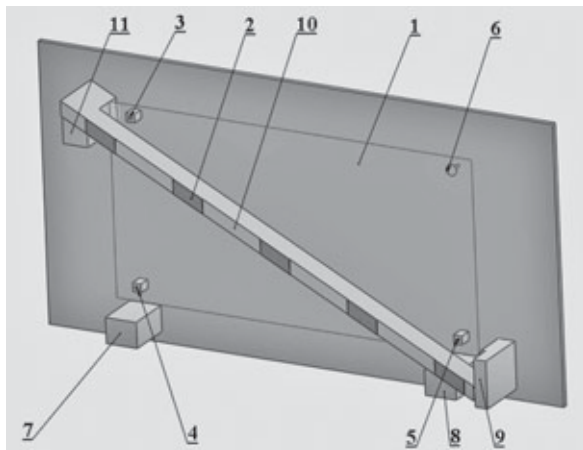
The aim of our studies was to analyse the influence of species of different shrinkage on the geometric stability of furniture elements in asymmetrical veneering. Boards were veneered on both large sides or on only one large side using an elastic bonding adhesive.

## 2 MATERIALS AND METHODS

### 2. MATERIJAL I METODE

Measurements were done on a specially designed stand. The stand is composed of elements as shown in Figure 1.

The main idea of the stand is to define a reference virtual plane (1). This plane is created with four pegs.



**Figure 1** The scheme of the measurement station (explanation in the text)

**Slika 1.** Shema mjerenja (opis u tekstu)

Three of them have a constant height of 30 mm (3, 4, 5). The fourth is adjustable (6) in order to avoid deflection of the sample, which is attached to the pegs. The force is axially positioned with pegs. During measurements, panels are always placed equally in position to each peg. The position of the panels is secured with three fixed blocks (7, 8, 9). The visible surface of the strip (10) forms the reference surface. The strip is placed with three blocks (8, 9, 11). The distance between the reference virtual plane and reference surface of the strip is constant. This is where the measured board is placed. The geometry is measured in five areas (2), five times in each area (3 mm gap) with a depth gauge. Its precision is 0.01 mm, and measurement error is 0.02 mm.

Four samples of the dimensions of 900 x 450 mm and 18 mm thick were veneered in the same way. After veneering, boards were conditioned at  $20 \pm 2$  °C and  $65 \pm 5$  % relative humidity for seven days. All the boards were measured in three states, as follows: unveneered board, unvarnished asymmetrically veneered board and varnished asymmetrically veneered board.

For choosing veneer pairs (each on one large side), a comparison was made of the linear shrinkage values of wood species. Contractions in volume for the used veneers are as follows: Beech (*Fagus sylvatica* L.) - 11.8%, African ebony (*Diospyros spp.* Hiern) - 12.8 %, Macassar ebony (*Diospyros celebica* Bakh.) - 5.1 % (EN 13556; Kokocinski, 2004). Porosity was defined basing on wood density according to standard equation (Kokocinski, 2004): porosity of African ebony – 20 %, porosity of beech – 55 % and porosity of Macassar ebony.

Studies were divided into three steps of different shrinkage value: 1 - small difference of shrinkage values: 11.8/12.8 %, 2 - significant difference of shrinkage values: 5.1/11.8 % and 3 - large difference of shrinkage values: 11.8/0 %.

All the boards were veneered using the same type of elastic bonding glue with the following characteristics: viscosity 2.5 Pa·s, density 0.80 g/cm<sup>3</sup>, Young modulus 2480 MPa (Papadopoulos *et al.*, 2002; Konnerth and Gindl, 2006), Poisson's ratio 0.3 (Konnerth *et al.*, 2007), contact angle 81° (Oleńska *et al.*, 2012) and spread 150 g/m<sup>2</sup>. Linear shrinkage - 1.4 % and volume shrinkage - 4.2 % of glue were measured according to the method of Jakubiak and Linden (2001). Shore's hardness - 51 HD was measured according to PN- EN ISO 868: 2005P and ISO 7619-1. In addition, the following parameters of veneering were constant: pressure 1.5 MPa, temperature 22 °C, time 240 min.

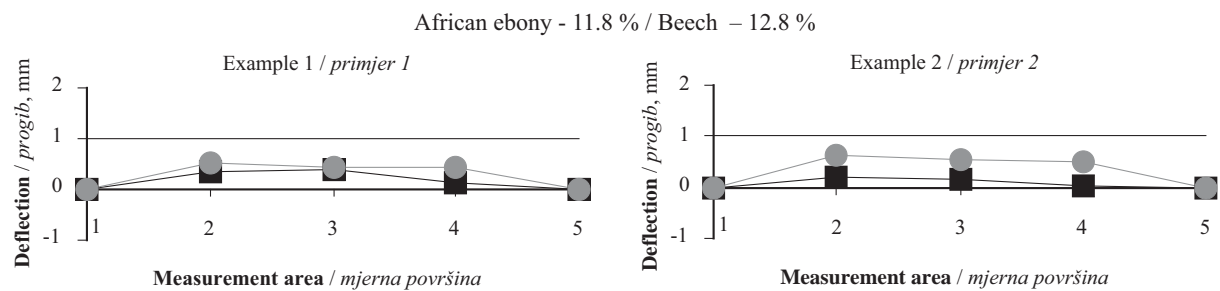
## 3 RESULTS AND DISCUSSION

### 3. REZULTATI I RASPRAVA

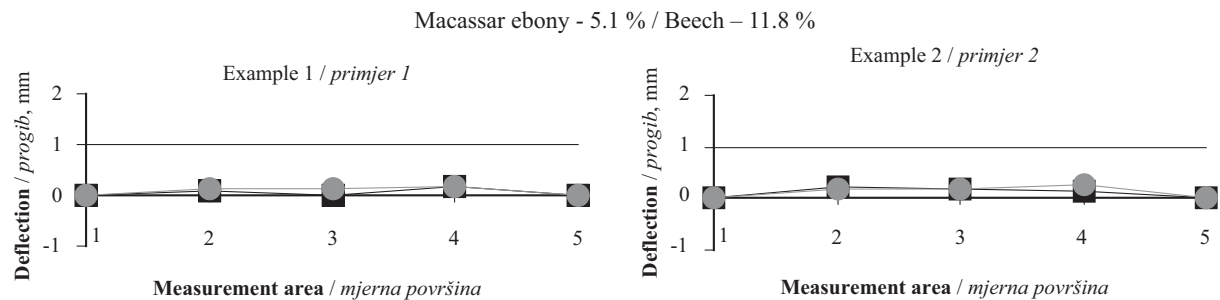
Figures 2 and 3 show as follows:

- – difference between unveneered board and board veneered on both sides, unvarnished,
- – difference between unveneered board and board veneered on both sides, varnished.

Figures 2 and 3 show the results of the studies performed on board veneered on both sides. Beech ve-



**Figure 2** Deflection of the board asymmetrically veneered on both large sides - small difference of shrinkage values  
**Slika 2.** Progib ploče koja je asimetrično furnirana s obje strane - mala razlika između vrijednosti utezanja



**Figure 3** Deflection of the board asymmetrically veneered on both large sides - significant difference of shrinkage values  
**Slika 3.** Progib ploče koja je asimetrično furnirana s obje strane - značajna razlika između vrijednosti utezanja

neer (*Fagus sylvatica* L.) is on one side. Figure 2 shows examples of the results obtained for the board veneered with African ebony (*Diospyros spp. Hiern*) on the other side - small difference of shrinkage values. Figure 3 shows examples of the results for the board veneered with Macassar ebony (*Diospyros celebica Bakh.*) on the other side - significant difference of shrinkage values.

The results of these studies show that the chosen glue provides shape stability after the process of both-side asymmetrical veneering, even if the shrinkage difference was high, and the values of deformations were low. At the critical point of deformation, boards 1 and 2 reached 0.51 mm and 0.61 mm, respectively.

Larger geometric deformations of boards 1 and 2, even for small difference of shrinkage values, can be explained by differences in the porosity of veneers. In boards 1 and 2, the porosity difference between African ebony and beech was 35 %. In boards 1 and 2, the porosity difference between Macassar ebony and beech was only 13 %. Thus, it seems that porosity, apart from shrinkage, is one of the main factors determining stability of asymmetrical veneered panels.

Figure 4 shows the results of the studies made on one-side veneered board using beech veneer - large difference of shrinkage values. The following variables were used:

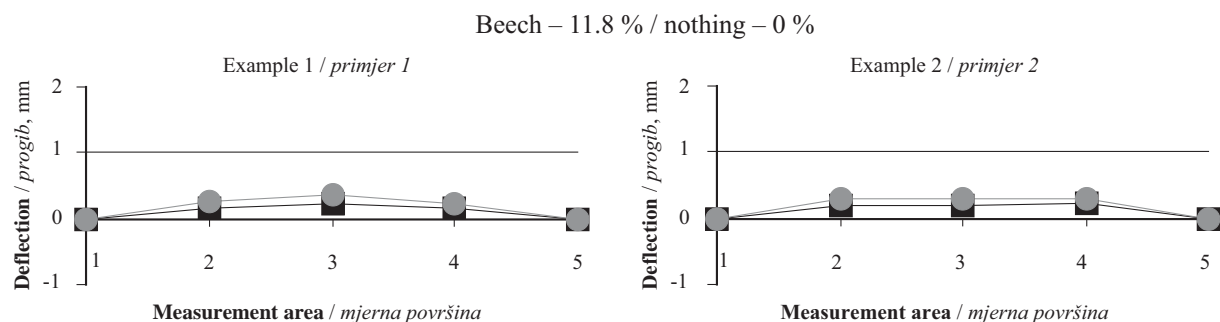
- – difference between unveneered board and one-side veneered board, unvarnished,
- – difference between unveneered board and one-side veneered board, varnished.

The results of these studies show that the examined adhesive provides stability of shape of the samples after veneering. Another advantage of the elastic glue bond line is small geometric deformation. At the critical point, deformation reached 0.37 mm.

#### 4 CONCLUSION 4. ZAKLJUČAK

Samples veneered with elastic glue joint preserve their shape, or their deflection is small. Therefore, obviously the properties of glue joint contribute much to the level of geometric deformations of the board.

Studies show that shrinkage in hardwood species does not have an influence on deformations in the ve-



**Figure 4** Deflection of boards asymmetrically veneered on one large side – large difference of shrinkage values  
**Slika 4.** Progib ploče koje su asimetrično furnirane s obje strane - velika razlika između vrijednosti utezanja

neered board. The porosity of species used was the main factor affecting the deformations of asymmetrically veneered boards.

A high difference in porosity values causes higher geometric deformations of asymmetrically veneered boards. This can be solved by using optimised technology of gluing and varnishing.

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