ASSESSING THE SHAPE STABILITY OF PARTICLEBOARDS SURFACE-TREATED BY DECORATIVE VENEER

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Abstract

The paper summarizes results of research work aimed at the determination of shape stability, modulus of rupture (MOR) and modulus of elasticity (MOE) of components manufactured of particle boards, which were veneered from their tight side by the decorative veneer of American walnut (Juglas nigra) 0.6 mm thick and on the underside by decorative veneers of different species 0.6–1.5 mm in thickness or by a countermove foil of 85–90 g/m² surface weight. Subsequently, measurements were carried out of the shape stability (warping) of test specimens cut from various combinations of surface-finished boards. These test specimens were air conditioned in three different environments. At the same time, values were determined of bending strength and modulus of rupture with respect to the direction of fibres of sheathing materials

Keywords: *veneer, veneering, panels, warping, shape stability*

INTRODUCTION

Demand for aesthetically marked wood is high abroad. However, considerable costs for logging operations, certification, transport and limited supplies of exotic wood cause increasing the price of input raw materials for the manufacture of decorative veneers. For these reasons, the production and application of modified veneers develops, which makes possible to use less marked veneers particularly on invisible surfaces of products. At present, efforts of manufacturers to replace expensive veneers on invisible surfaces by countermove materials are much extended. The function of these materials is to provide shape stability of furniture elements. A basic question is what countermove material can be ranked among concrete kinds of wood and what relationships exist between them. Determination of these relationships will contribute to create suitable combinations of veneers to provide shape stability, which will make possible production plants to obtain competitive advantages by means of decreasing production costs (Král and Hrázský, 2005)

Generally, warping is the undesirable shape deformation of elements. An area element was examined, which consisted of a particleboard as supporting part and two covering veneer layers or a countermove foil was used as one layer. From the aspect of shape stability, the main problem of veneered elements consists in different dimensional changes of materials occurring in particular layers.

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If materials creating particular layers were not stuck (connected) together, moisture changes would become evident in the change of their dimensions. However, larger dimensional changes of surface decorative layers would become evident. After the connection of particular layers by means of bonding in the process of hot pressing into one compact unit the shift of particular layers of the composite material is prevented. At the same timer, however, it is necessary to take into account that due to this firm connection a certain stress occurs in particular layers at moisture changes, which acts on this sheet composite material. If the sum of planar static moments is equal to zero then the element preserves planeness. This condition is valid providing the surface composite material is compiled (put together) symmetrically, i.e. using identical surface layers. In case the sum of planar static moments is not equal to zero the element is deformed. Therefore, there is always an endeavour to create a composite material which is most consistent with the theory of veneering, i.e. to achieve the symmetrical lay-out of materials (Avramidis et al., 2011).

MATERIAL AND METHODS

To determine shape stability, bending strength and modulus of elasticity in bending elements with various combination of veneers or countermove foils were manufactures under laboratory conditions. To determine relationships between the veneer and countermove foil thickness two thickness series of beech and spruce veneers were created. These variants are given in Tab. 1. From each of the variants, two elements were manufactured 16 mm particleboards being the bearing (supporting) part of the elements. The elements were manufactured from particleboards 2800 x 2070 mm.

Table 1. Combination of veneers

Veneer combination		
Tight side	Underside (countermove side)	Countermove layer thickness (mm)
Nut (NU)	Nut (NU)	0.6
Nut (NU)	Alder (AL)	0.6
Nut (NU)	Spruce (SP)	0.6
Nut (NU)	Spruce (SP)	1.2
Nut (NU)	Spruce (SP)	1.5
Nut (NU)	Beach (BE)	0.6
Nut (NU)	Beach (BE)	0.9
Nut (NU)	Beach (BE)	1.2
Nut (NU)	Beach (BE)	1.5
	Countermove foil 85–90 g/m^2	-

For gluing was used urea-formaldehyde glue average glue spread being 155 g/m^2. The amount of applied glue was determined by a weight method on check samples. At the application of a countermove foil the glue spread was 80 g/m^2.

Pressing the sets was carried out using a one-stage press under following parameter:
- pressing time   60 s/1 mm veneer thickness + 300 s
- pressing temperature   110 °C
- working pressure   0.6 N/mm^2

After pressing, the elements were stored in a stack for temperature, moisture and curing the glue to be balanced. After the termination of air-conditioning, all elements were trimmed to a size of 400 x 760 mm. This size was subsequently used for cutting test specimens for the determination of bending strength and modulus of elasticity in bending according to the CSN EN 310 standard. Seven test specimens were prepared with the cross course of fibres and 8 test specimens with the longitudinal course of fibres, namely of each of material combinations.

The determination of warping (shape stability) was carried out according to the CSN 490148 Standard. To prevent the penetration of water vapours into test specimens their lateral surfaces were painted with a water-soluble white paint. Thus, porous lateral edges of particleboards were sealed. The measurement of warping was carried out by means of an aluminium lath and digital slide gauge measuring with accuracy to 0.01 mm.

Air conditioning was carried out with the aim to create stress in surface layers of elements/components with the subsequent origin of the different size of warping. The test specimens were placed in the air-conditioning box on a shorter lateral area for forces preventing warping not to originate. Gaps among particular layers were ensured by a locking lath in such a way that changes in gap dimensions could not occur for the period of measurement. According to the CSN 490148 Standard, the value of warping in a respective direction is always the highest determined deviation in this direction. It is rounded to 0.1 mm being related to 1 meter length (mm/m).

Bending strength and modulus of elasticity in bending at particular test specimens were determined according to the CSN EN 310 Standard..

RESULTS AND DISCUSSION

Determined values of warping after 27 days depending on the countermove veneer thickness is give in Tab. 2.

Table 2. Values of warping after 27 days of air conditioning

Values of warping in mm/m after 27 days of air conditioning			
Countermove layer	Direction of measurement		
	Longitudinal	Perpendicular	Y
SPRUCE 0.6 mm	2.8	1.5	0.7
BEECH 0.6 mm	1.7	2.0	0.3
WALNUT 0.6 mm	1.4	1.0	0.4
ALDER 0.6 mm	1.4	2.0	0.3
Foil	26.4	2.0	0

Values of warping after 27 days of air conditioning an alder veneer 0.6 mm thick appears to the most suitable countermove material. In longitudinal direction, warping amounting to 1.4 mm/m was determined, in perpendicular direction 2.0 m/m and a value Y expressing warping corn-wise 0.3 mm/m.At the use of a countermove foil, surprisingly high values of warping were found in longitudinal direction. After the 14-day air conditioning of elements, these values were up to 13.89 times higher than at the reference symmetrically veneered element.

Simple of results of the measurement of density, bending strength and modulus of rupture including characteristics of descriptive statistics are given in Tab. 3.

Table 3. Values of density, modulus of elasticity in bending (MOE) and modulus of rupture (MOR)

Countermove layer – alder (OL) 0.6 mm									
	Longitudinal course of fibres					Perpendicular course of fibres				
Stat. value	F_{max} (N)	MOR (N/mm^2)	MOE (N/mm^2)	ε (mm)	ρ (kg/m^3)	F_{max} (N)	MOR (N/mm^2)	MOE (N/mm^2)	ε (mm)	ρ (kg/m^3)
n	8	8	8	8	8	7	7	7	7	7
$\overline{x}$	821	30.08	4201	10.7	643	285	10.46	1965	7.09	641
s	48.8	1.78	166	1.0	10.01	19.18	0.72	19.46	0.68	2.7
V (%)	5.94	5.91	3.97	9.36	1.56	6.72	6.92	0.99	9.63	0.4
Min.	743	27.29	3953	8.74	633	259	9.46	1936	6.17	638
Max.	890	32.57	4447	11.7	661	313	11.55	1993	8.05	645

Providing dependence between sheathing materials and values of MOR and MOE of veneered materials values of warping and MOE and MOR were also compared both in longitudinal and perpendicular directions and statistical evaluation of the modulus of elasticity at test specimens with the longitudinal course of fibres (P) and perpendicular course of fibres (K). At first, the one-dimensional test of significance was carried out, and then the Tuckey HSD test of multiple comparisons..

Demonstration of the relation of mean values MOE–P is given in Fig. 1.

The reason of creating asymmetrically veneered elements is to use financially less demanding (cheaper) materials on the invisible surface of an element. The function of this material is to provide shape stability.
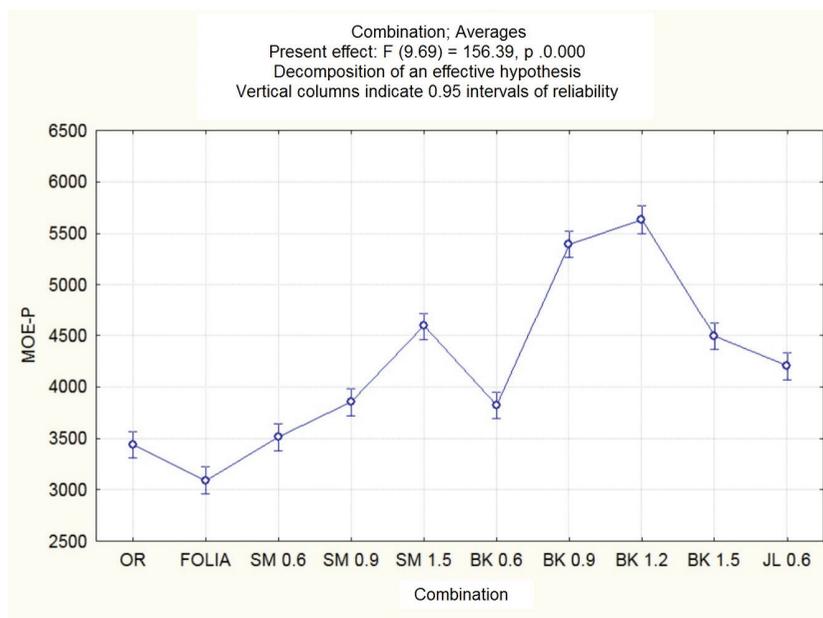
Note: OR – Walnut,   Foil,   SM – spruce, BK – beech, JL – elm, OL – alder

Figure 1. Demonstration of the relationship of mean values MOE–P

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CONCLUSION

With increasing demands for decorative veneers their shortage increases and thus their price also grows. Increasing efforts to reduce production costs force producers to look for possibilities how to reduce prices of inputs and search for new technical solutions of products. This paper was aimed at searching suitable countermove materials for the underside of veneered elements. One of tasks of the countermove layer is to provide the shape stability of a surface-finished element by means of veneering. Already in the production stage, it is necessary to eliminate effects of factors influencing the shape stability of the elements. Because asymmetrically veneered elements are more liable to shape changes (warping) than elements veneered symmetrically it is more suitable to use materials, which can minimize the creation of moisture differences within an element, such as adhesive foils. At veneering particular elements the thickness of used veneers has to be always the same. Results of the measurement of warping the elements veneered by various combinations of veneers and a countermove foil showed that the combination of American walnut 0.6 mm and alder 0.6 mm provided the smallest values of warping. This material combination makes possible to achieve savings. Veneers American walnut 0.6 mm and alder 0.6 mm represent cost savings amounting to 5.31 €/m^2 . At searching for relationships between values of warping and MOE values in longitudinal and perpendicular directions, MOE correspondence (congruence) was found at elements with countermove layers American walnut 0.6 mm and spruce 0.6 mm.

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