glue, a single layer chip mat is formed. The mat is pressed of 3 MPa and a normal air temperature within 1 min and then is fed to the operation of pressing composite. Pressing single layer boards of density 650 kg/m³ and a thickness of 16 mm is performed under the following schedule: pressure of 2.2 MPa, temperature of 170 °C, duration of 0.38 min / mm (6.14 min). Humidity of finished composites was 8%.

It is experimentally proved that WCM produced by traditional technology with adding layers up to 30% of rape particles have mechanical properties that meet the National Standard of Ukraine (DSSU EN 312-2:2003) (Table 2).

Table 2. Properties of WCM

Tensile strength in static bending, MPa	12,3
Tensile strength perpendicular to the plane of a surface, MPa	0,28
Water, %	85
Swelling, %	32

Wood-based materials produced manufactured with adding more than 30% of the filler material from rape raw of coarse fraction are characterized by a high aesthetic quality and low surface roughness and can be used as faced wall panels without additional mechanical conversion.

Conclusions. Thus, proving rape waste into the manufacture of wood composites allows to expand the raw resources and to reduce the cost of materials and consequently save valuable wood raw material, that is extremely important for rarely forestry regions of Ukraine.

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УДК 674.023.0 ***Доц. М.М. Копанський, канд. техн. наук – НЛТУ України***

Виготовлення деревинних композитів з використанням відходів ріпаку

Проаналізовано компонентний склад, будову рослинної сировини виготовленої із стебел ріпаку з точки зору перспективності їх використання у виробництві стружкових плит та інших композиційних матеріалів. Наведено основні технологічні аспекти виготовлення деревинних композитів з використанням ріпакової сировини та деякі їх фізико-механічні показники.

Ключові слова: деревинні композиційні матеріали, стружкові плити, рослинна сировина, фізико-механічні властивості, стебла ріпаку.

UDC 691.11:674.8:531.717.8 ***Post-graduate I.O. Kiyko – UNFU***

INFLUENCE OF THE STRUCTURAL ELEMENTS' PLACEMENT OF THE FURNITURE BOARDS ON THEIR SHAPE STABILITY

Furniture boards made from wooden wastes have a number of the significant economic and environmental benefits in relation to their use in furniture and woodworking industries in comparison to the usual furniture boards made from wooden timber which are connecting into furniture boards in size of length using finger ironings and in size to the width – using adhesive on the smooth puffer. One of the possible disadvantages of the furniture boards made from structural elements of small size is a deviation from flatness that sometimes exceeds the permissible value. Comparison of deviation from

flatness of furniture boards with directions along and across the fibers for two different schemes for placement of structural elements – parallel and perpendicular was done. Conclusion about better shape stability for the furniture boards, in which there is perpendicular scheme of the structural elements' location, was suggested.

Keywords: furniture boards made from wooden wastes, deviation from flatness, parallel and perpendicular schemes of structural elements placement.

Rationale. The author of this researches has suggested the design and manufacturing process of furniture boards made from wood waste accumulated during woodworking [1, 2 , 3]. Previous studies have also found [3] that the change in the linear dimensions of the structural elements of furniture board has a significant impact on the deviation from flatness of such board. It is likely that the structural placement of the wooden items in the furniture boards made from wood waste will make the impact on the shape stability of furniture boards.

Therefore, the objectives of the research presented in this paper are the following.

- Comparison of the absolute values of deviations from flatness defined in direction A and direction B for experimental samples of the furniture boards produced by parallel and perpendicular schemes.
- Comparison of the occasional deviations from flatness defined in direction A and direction B for experimental samples of the furniture boards produced by parallel and perpendicular schemes by testing statistical hypotheses about the homogeneity of variances and homogeneity of the medium values and establish the presence of correlation relations between them.
- Making conclusion in regard to shape stability of the furniture boards produced by parallel and perpendicular schemes.

Methodology of the researching. During the researching, according to the technology [3] furniture boards with various schemes of the structural elements placing were produced with respect to the direction of the fibers (Fig. 1 and Fig. 2).

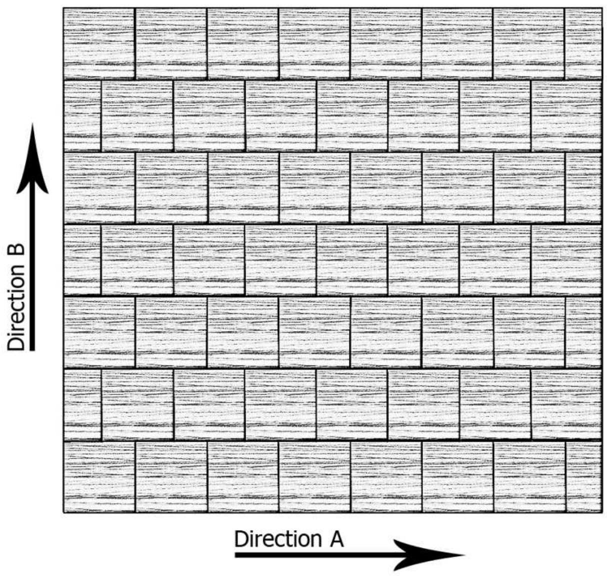

Fig. 1. General view of the furniture board sample №1 *with parallel scheme of structural elements placement*

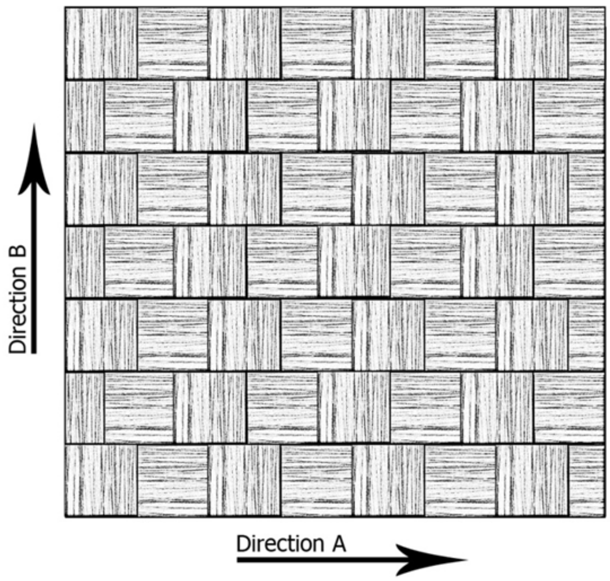

Fig. 2.General view of the furniture board sample №2 *with perpendicular scheme of structural elements placement*

(dimensions of structural elements: L = 40 mm B = 40 mm)

In order to implement experimental studies it was made three samples of two sizes of experimental models of furniture boards produced from solid wood waste of alder (Fig. 1 and Fig. 2) using size 300 × 300 mm. Deviation from flatness measurement was carried out using a numerical indicator ICHTS (3)-25-0,01 (measurement accuracy – 0.001 mm). These data were read by the software produced by the Microtech (Ukraine)company type UYS-P1-COM and transferred to Microsoft Excel environment for recording and processing. Measurements were removed from the experimental sample furniture boards in two directions (along the fiber direction – direction A, across the fibers direction – direction B). In each of the directions of furniture board measurements were carried out in 6-th conditional lines. As a result, measurements on each line it was recorded from 300 to 360 points. Thus the results of one measurement it received sample of volume from 1800 to 2160 (6 × (300 ... 360)). The experimental deviation from flatness estimated using a mean value of the sample.

Experimental values of the output value (table 1) were obtained as the difference between the mean values of samples obtained for the first and last measurement (in absolute value),moreover the first measurement was carried out after approximately two weeks from the date of the experimental sample furniture board manufacturing and the last measurement was determined by invariance of the deflection (deflection measurement is not continued if the value of the last boom deflection measurement differs from the previous one by no more than 5%). It was conducted four series of measurements in the experiment and deflection value is defined as the difference between the first and fourth experiments. During the researching also tested the statistical hypothesis about dispersion homogeneity and sample averages homogeneity for two samples – a deviation from flatness that was defined in the direction along the fibers (sample 1) and across the fibers (sample 2). The samples were obtained by averaging of the results for each of the six conventional lines for each of the direction of furniture boards with parallel and perpendicular arrangement scheme of structural elements. Testing of the statistical hypotheses about the homogeneity of two dispersions was performed in that order.

1. For two samples with volumes N_1 and N_2it was calculated their dispersion S_1^2 and S_2^2 ($N_1 = N_2 = 355$).

2. The calculated value of the Fisher criterion was calculated as the ratio of more dispersion to less one:

$$F_{cal} = \frac{S_1^2}{S_2^2}, \text{ if } S_1^2 > S_2^2. \quad (1)$$

3. The tabulated values of the Fisher criterion F_{tabl} was selected using distribution tables with Fisher for the selected significance level q and the number of freedom degrees f_1 and f_2.

4. It was compared values of the calculated and tabulated criteria. If $F_{cal} < F_{tabl}$,then the sample dispersionsS_1^2 and S_2^2 were considered as homogeneous and otherwise – it was believed that the difference between them was significant.

Testing of the statistical hypotheses about the homogeneity of average values was performed as follows.

1. It was calculated mean values $\overline{y_1}$ and $\overline{y_2}$ for two samples and their dispersion S_1^2andS_2^2.

2. It was calculated the estimated value of Student's criteria:

$$t_{cal} = \frac{\left|\overline{y_1} - \overline{y_2}\right|}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}, \quad (2)$$

3. It was selected value of the tabulated criteria t_{tabl} from Student's distribution tables using the accepted significance level q and the number of the freedom degrees $f=N_1+N_2-2$.

4. It was compared values of the calculated and the tabulated criteria. If $t_{cal}<t_{tabl}$, the hypothesis of homogeneity of the medium was assumed. Otherwise –it was concluded there is a significant difference between the averages of two samples.

Also it was established the presence of correlation between the magnitude of the deviation from flatness defined in two directions: along and across the fibers using correlation coefficient. Selective correlation coefficient r was calculated from the expression (3) after calculating the average values $\overline{y_1}$ $(y_1=S_l)$ and $\overline{y_2}$ $(y_2=S_b)$, their dispersion S_1^2 and S_2^2 and standard deviation S_1 and S_2.

$$r = \frac{\sum_{i=1}^{N}(y_{1i}-\overline{y_1})\cdot(y_{2i}-\overline{y_2})}{(N-1)\cdot S_1\cdot S_2}. \quad (3)$$

For the determination of correlation relation absence it was calculated value of the calculated Student criteria:

$$t_{cal} = |r|\cdot\sqrt{\frac{N-2}{1-r^2}}, \quad (4)$$

The calculated value t_{cal} was compared with the tabulated value of the Student's criteria t_{tabl}, which was chosen due to significance level q and the number of the freedom degrees of f = N- 2. If $t_{cal}<t_{tabl}$, the hypothesis about absence of the correlation between two random variables was assumed. If $t_{cal}>t_{tabl}$, it was considered that a sample correlation coefficient is significantly different from zero or in other words, there is a linear statistical relationship between two random variables.

Researching results. Researching results for samples of furniture boards with parallel and perpendicular placement schemes are presented in Fig. 3 and Fig. 4.

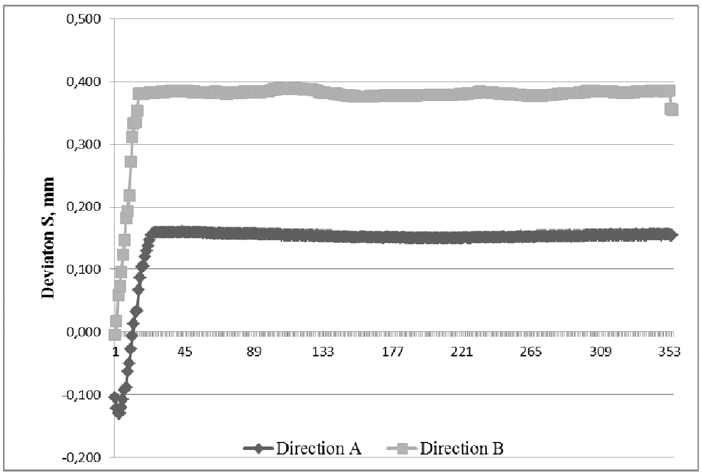

Fig. 3. Value of the deflection (deviation S) for the experimental sample number 1 *(the length of the structural element L = 40 mm, width of the structural element B = 40 mm; placement scheme of the structural elements – parallel in such directions: along (direction A) and across (direction B) fibers)*

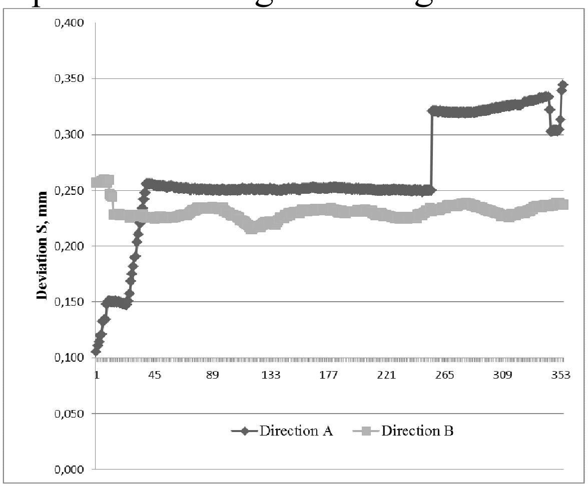

Fig. 4. Value of the deflection (deviation S) for the experimental sample number 2 *(the length of the structural element L = 40 mm, width of the structural element B = 40 mm; placement scheme of the structural elements – perpendicular in such directions: along (direction A) and across (direction B) fibers)*

The results of the statistical test of the hypothesis of homogeneity of the medium of two random variables (deviation from flatness defined in direction A and direction B), which received two aggregate sample which are presented in Table 1.

Table 1. Results of testing of the hypothesis of homogeneity of average of two samples (S_l deviation in the longitudinal and transverse directions S_b)

№ of the experimental sample of the furniture board	Dimensions of the structural elements of the furniture board		Average value of the deviation from flatness S, mm		The relative difference between the values of the deviations in the direction A and Direction B, %	Testing of the hypotheses about the homogeneity of the means for two samples (S_l deviation in the longitudinal and transverse directions S_b)		
						calculated and tabulated value of Student criteria		conclusion about homage of two means
	L, mm	B, mm	in the direction along fibers (dir. A), S_l	in the direction across fibers (dir. B), S_b		t_{cal}	t_{tabl}	
1	40	40	0,144	0,373	160	65,5	1,96	difference between the averages is significant
2	40	40	0,261	0,230	12	12,03	1,96	

As it is shown in the Table 1, in two cases, for various schemes of the structural elements placing the calculated value of Student criterion is more than the tabular value of this criterion and therefore we concluded that the differences between the means of the random deviations from flatness in the directions along and across the fibers is significant and these average values cannot be considered as homogeneous. It should also be noted that the relative difference between the deviations in the directions A and B for furniture boards of the perpendicular placement (sample number 2, Fig. 2) is substantially less than the same difference for furniture boards of the perpendicular placement(sample number 1, Fig. 1.) – 12 and 160%, respectively.

The results of the statistical test of the hypothesis of homogeneity of the dispersions (Table 2) showed that the difference between the sample means of two random variables deviations from flatness in different directions is significant for both: for furniture board with parallel arrangement scheme of structural elements and for furniture board with a perpendicular arrangement scheme of these elements.

Table 2. Results of testing in regard to the hypothesis of homogeneity of variances of the two samples (S_l deviation in the longitudinal and transverse directions S_b)

№ of the experimental sample of the furniture board	Dimensions of the structural elements of the furniture board		The average value of the dispersion for deviation from flatness		Testing hypotheses about the homogeneity of the dispersions for the two samples (deviation in the longitudinal and transverse directions)		
	L, mm	B, mm	in the direction along fibers (dir. A), S_l, mm	in the direction across fibers (dir. B), S_b, mm	calculated and tabulated values of the Fisher criteria		conclusion about the homogeneity of the two dispersions
					F_{cal}	F_{tabl}	
1	40	40	0,0021	0,0022	1,06	1,00	heterogeneous
2	40	40	0,0023	0,00005	51,1	1,00	heterogeneous

It should be noted that the relative difference between the average values of the deviations from flatness in different directions in the case of parallel placement makes up 160 %, while a similar difference for perpendicular arrangements of the structural elements makes up only 12 % (Table 1). However, as a result, we concluded that the two samples (for deviation S_l and for deviation S_b) are not the members of the sane total population and the difference between two sample means and sample dispersions cannot be explained by random errors. Obviously, the above described difference is related to the influence of certain non-random factors. Therefore it is logical to assume that the deviation from flatness in the direction along the fibers and the deviation from flatness in the direction across the fibers for furniture boards with different placement schemes – these are two different random variables, characterized by different nature and causes.

As shown in Table 3, for the pilot sample furniture board with parallel in regard to the direction of fiber placement of structural elements (sample number 1) between two random variables (deviation from flatness toward the direction A and B) there is a statistical relationship, namely by changing a random variable it will change the distribution of the other one. Also for the experimental sample is likely to assume the presence of a direct line of communication, as the sample correlation coefficient value is positive (Table 3).

Table.3. Results of testing of the hypothesis about the presence of the statistical (correlation) connection between two random variables (S_l deviation in the longitudinal and transverse directions S_b)

№ of the experimental sample of the furniture board	Dimensions of the structural elements of the furniture board		Value of the selective correlation coefficient r for two random values: S_l deviation in the longitudinal and transverse directions S_b	Testing hypotheses about the correlation connection for the two values (deviation in the longitudinal and transverse directions)		
				calculated and tabulated value of Student criteria		Decision about a statistical (correlation) connection
	L, mm	B, mm		t_{cal}	t_{tabl}	
1	40	40	0,94	53,2	1,96	there is linear statistical connection
2	40	40	-0,11	2,05	1,96	

The presence of a linear inverse statistical relation (negative sample correlation coefficient) between the magnitude of the deviation from flatness specified in the direction along the fibers and the corresponding deflection specified in the direction across the fibers it can observe for the experimental sample of the furniture board number 2 (perpendicular to the placement of structural elements).

For sample of the furniture board with perpendicular placement of structural elements (Table 2), the calculated value of Student criterion makes up t_{cal} = 2,05which is more than the tabular value of the Student criterion ($t_{tabl.}$=1,96), which is defined for a significance level q = 0,05 (on the basis of this comparison it was concluded that there is a correlation). It is interestingly, if we take q = 0,01 (to increase uncertainty in the decision of statistical hypotheses from 5 to10%), the value of the tabular value of the Student criterion will increase and will make up $t_{tabl.}$ = 2,58, which will allow in this case to conclude that there is no statistical relationship between deviations from flatness of the furniture boards specified in the directions along and across the fibers.

Conclusions. Thus, as a result of the comparing the deviations from flatness for furniture boards for parallel and perpendicular placement of the structural elements (Fig. 1) it was made the following conclusions.

1. Two samples (deviation from flatness of the furniture board in direction along the fibers S_l and deviation from flatness across the fibers S_b), the two placing schemes of the structural elements (parallel

and perpendicular) does not belong to the same total population and the difference between two sample means and two selective variances of these variables cannot be explained by random errors.

2. Relative difference between the average values of the deviations from flatness in different directions (A and B) in the case of parallel placement makes up 160 %, while a similar difference for perpendicular arrangements of the structural elements makes up only 12%.

3. For the experimental samples of the furniture boards with perpendicular arrangement scheme of structural elements, with a significance level q = 0,01, it can accept the hypothesis that there is no statistical correlation between the two these values of the deviations from flatness in the direction A and direction B, that together with conclusion 2 may indicate a better shape stability of furniture boards with perpendicular placement of structural elements in comparison with similar furniture boards that are made by the parallel scheme.

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УДК 691.11:674.8:531.717.8 ***Аспір. І.О. Кійко – НЛТУ України***

Вплив розміщенняструктурних елементів клеєних щитів на їх формостійкість

Меблеві щити, виготовлені з кускових відходів деревини, мають ряд суттєвих економічних та екологічних переваг щодо використання їх у меблевому і деревооброблювальному виробництвах у порівнянні із класичним меблевими щитами, виготовлених з ламелей шляхом з'єднання у меблевий щит у розмір за довжиною за допомогою зубчастих шипів і у розмір за шириною – за допомогою склеювання на гладку фугу. Одним із імовірних недоліків меблевих щитів, виготовлених із структурних елементів невеликих розмірів є відхилення від площинності, що інколи може перевищувати допустимі значення. дійснено порівняння величини відхилення меблевих щитів від площинності у напрямках вздовж і поперек волокон для двох різних схем розміщення структурних елементів – паралельної і перпендикулярної. Здійснено висновок про кращу формостійкість меблевих щитів, у яких структурні елементи розміщені за перпендикулярною схемою.

Ключові слова: клеєний щит із кускових відходів, відхилення від площинності, паралельна і перпендикулярна схеми розміщення структурних елементів.

UDC 674:630 ***Senior teacher I.Z. Pylypiv; assoc. prof. O.I. Dumanskyy – UNFU***

BUILDING MATHEMATICAL MODELS DEPENDING ON BEND RADIUS FIBER BOARDS CONCERNING ITS THICKNESS AND HYDRATION TIME

Submitted by processing experimental studies necessary for the production of curved pieces of furniture with fiberboard. Found a mathematical dependence studied processes using methods of interpolation and approximation. Presented minimum radius curved pieces of furniture in the thickness of plates and different moisture conditions adhesive.

Keywords: curved furniture element, fiberboard, minimum radius, interpolation, approximation.

Recently, the development of design and construction in order to improve consumer properties of furniture products significantly changed the approach to the formation processes of production and management domain-spatial environment of human life. The design of contemporary furniture unacceptable standard solutions. The im-