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A COMPARATIVE ANALYSIS OF PHYSICAL-AND-MECHANICAL PARAMETERS OF VARIOUSLY-DESIGNED GLUED BOARDS MADE OF POST-CONSUMER RECOVERED WOOD

The basics of classification, methods of cleaning and processing post-consumer wood (PCW), are considered in this work. It is proposed to convert PCW into glued boards (GB). A comparative analysis of physical-and-chemical parameters of conventional GB as well as variously constructed GB from recovered wood (RW), has been made. A regression model is created to predict GB static-bending strength across strips with the GB's thickness being 22 mm depending on the strip width and glue consumption.

Keywords: wood, post-consumer wood, glued boards, woodfibre board, woodparticle board, plywood, recovered wood, waste recycling, waste management.

Background. Today millions of tons of used millwork and old furniture are thrown away to dumps just because their service-life is considered to have been up according to modern ideas on fashion; at best, the used wooden goods may find themselves somewhere in the countryside homes or summerhouses. However, the rules and regulations adopted in most European countries with regard to environmental protection, force manufacturers of woodworking industry to seek other ways of processing and utilization of raw materials of this kind. Starting from March of 1992 on, it has become a mandatory condition in France and Germany to have for manufactured goods the mark "ES" – meaning "Environmentally Sound". It is given to articles which do not have an adverse impact on the environment during the period of their live and their further recycling. Thus, the industrial use of the recovered used wood – PCW is not only a powerful contributor to increasing raw material resources in woodworking industry but this will soon become imperative from ecological line of consideration.

Our previous studies show that it is possible to obtain boards, bars, strips as well as technological chips from used wooden articles – PCW (old furniture pieces and other woodwork). It should be noted, however, that such wood often has many defects both manufacturing (shears, holes, scratches) and natural (stains, rot), which makes it impossible for applications with transparent finishing. Therefore, it should be used where the appearance dost not count much. The furniture material in which such wood can be used, are woodparticle board (WPB), woodfibre board (WFB) and GB. As world practice shows, the RW has already been used in the form of chipped wood particles as addition to the main furnish in manufacturing WPB. As a version of integral (non-chipped) usage of cleared RW are GB, which are considered to be environmentally sound, strong, and light in weight, structural material.

GB [3, 4] are subdivided into three types according to their construction and production techniques:

- US – the core composed of unbonded strips;
- BS – the core composed of bonded strips;
- PS – made of strips cut from a block of bonded thin pieces.

According to the core-board manufacturing accuracy, US type is of reasonable accuracy, BS and PS – of high accuracy, which is due to different shape stability of GB of differ-

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ent constructions. The boards of US type are regarded to have the highest shape stability. In order to ensure the shape stability of boards, glueing of veneer is done in the following way:

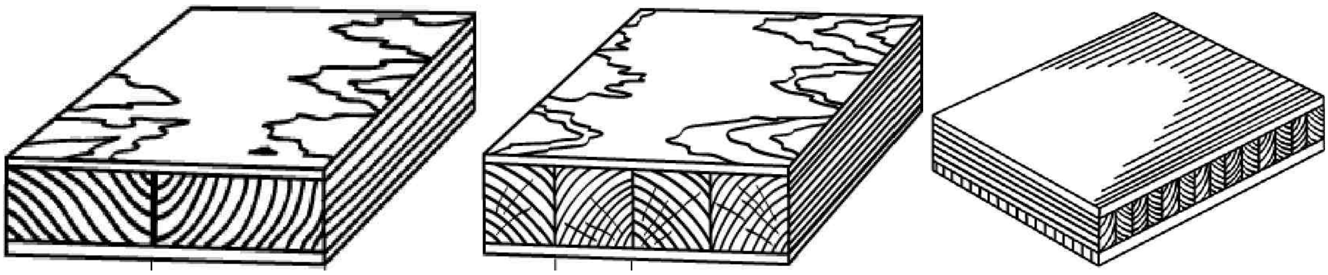
- the first veneer ply that is adjacent to the strips (called underlay) is made of high-grade peeled veneer;
- outer (face) ply of peeled veneer needs to have the same fibre direction as the underlay has;
- the outer ply and the underlay are made of the same wood-species veneer;
- the total thickness of the underlay and the outer ply of peeled veneer is to be no less than 3 mm;
- the board which is single-faced with sliced veneer, needs to have on the other side a balance layer of peeled veneer of the same thickness as the sliced veneer layer.

Depending on the quality of veneer used for outer layers, according to GOST 13713-78 "Glued boards. Specifications", GB are divided into three grades:

- unfaced boards: A/B, AB/BB, and B/BB;
- single-faced boards: I/B, and II/BB;
- double-faced boards: I/I, and II/II.

European analogies for GB of these types according to DIN 68705-2-2003 are as follows (fig. 1):

- **Battenboard** – a GB with the core made of bonded thin battens whose width does not exceed 3-fold maximum thickness, commonly ≤ 75 mm, edge-to-edge bonded, and faced with veneer (plywood, MDF).
- **Blockboard** – a GB with the core made of strips whose width does not exceed one maximum thickness, commonly 25 mm, faced with veneer (plywood, MDF).
- **Laminaboard** – a GB with the core made of strips of 6 to 7 mm thick and 25 to 30 mm in width, turned up on edge and glued face-to-face to create a stable block, double-faced with veneer or with three-, four-, or six-ply plywood.



Battenboard **Blockboard** **Laminaboard**

Fig. 1. Glued board constructions of European standards

Thus, the analogue to the GB of US type (GOST 13715-78) is **Battenboard (**DIN 68705-2-2003), respectively, BS type – **Blockboard**, and PS type – **Laminaboard.**

Tasks and experimental procedure. ***The objective of study*** – to analyze physical and mechanical parameters (static bending strength across strips, shearing strength along glue line according to GOST 13715-78 for conventional GB and GB made of RW).

The object of study – GB.

The subject of study – physical-and-mechanical properties of GB.

To achiev the objective, the following tasks have been carried out:

- to manufacture a GB from RW and a conventional GB;
- to make one hundred test specimens from GB of RW in order to determine the subordination of physical-and-mechanical properties of GB to the law of normal distribution in accordance with working standards;
- to make specimens to be used in the comparison of physical-and-mechanical properties of the manufactured boards;
- to make a comparative analysis of physical-and-mechanical properties of the boards obtained;

- to execute B-plan to reveal the extent to which physical-and-mechanical properties may depend on technological parameters, consumption of PVA glue which is used instead of urea-formaldehyde glue as well as establishing the optimum width of strips which is different in GOST 13715-78 and DIN 68705-2-2003;
- to optimize the object of study according to quadratic model;
- to draw conclusions and make practical proposals as to the results obtained.

Materials to be used for manufacturing GB [5-9]:

- wooden bars and rails from used window and door casings;
- woodparticle board (WPB, 16mm) from used elements of furniture pieces;
- woodfibre boards (WFB, 4mm) from used carcass backs of cabinets;
- three-ply plywood (4mm) from used furniture pieces;
- polyvinylacetate glue (PVA).

GB constructions and production techniques. GB are made as thick as 22 mm according to GOST 13715-78. To produce GB, old window frames cleared off ironmongery, window and door casings made of softwood species, were used. In addition, the material such as WPB cleared off facing, was used. According to GOST 13715-78, the thickness of peeled veneer jacket needs to make no less than 3 mm when using veneer of the first or second grade. Thus, the lower grade, the greater thickness.

The current production techniques involves using peeled veneer, plywood (PW), and WFB as materials for outer plies in manufacturing GB. Three-ply plywood and WFB were used to manufacture GB. The plywood was placed so that grain direction of outer plies would coincide with the longitudinal arrangement of the board’s strips while the core layer grain of the plywood would run crosswise the strips. Veneer of 1.5 mm thick was used in the tree-ply, plywood. Accordingly, there are two plies of veneer whore grain runs perpendicular to the strips of the veneered GB, the total thickness of these two plies being 3.0 mm. But we have four more outer layers of peeled veneer present that will add some more strength to the GB, which get to be determined during the test for static bending strength across the board’s strips. Thus, in testing for static bending strength across strips, our concern will be in determination of tension strength of these two veneer plies under stretching. It is well known, that wood tension perpendicular-to-grain is 20 to 30 times as less ar tension parallel-to-grain. Tension strength of these layers with respect to the core layer of plywood can be calculated as follows: $\sigma=2*(1/30)=0.066$ units (6.6 %) of the core layer tension strength.

Also, it should be taken into account that the two inner plies are subjected to compression at static bending as is generally known, compression. Strength perpendicular-to-grain is 4 to 6 times as less as that of parallel-to-grain, that is $\sigma=2*(1/6)=0.333$ units (33.3 %) of the core layer compression strength. In addition we obtain total strength of 6.6 % + 33.3 %=39.9 % ≈ 40 %. Since it is just some percent amount as compared with the longitudinal strength of 1.5 mm thick veneer, the strength like this would be available in the longitudinal veneer ply of 1.5*(40/100)=0.6 mm in thickness.

From this it follows that the strength of the two plywood layers with the above described manner of arrangement with respect to the board’s strips, at static bending yields the strength amount which is similar to that of a veneer ply of 0.6/2=0.3 mm thick. Accordingly, the total thickness of peeled veneer will amount to 1.5*2+0.3*2=3.6 mm. Thus, according to GOST 13715-78, the peeled veneer layers with total thickness of more than 3.6 mm, will correspond to the GB of 22 mm thick.

The manufacturing procedure for GB from RW involves the following steps: clearing the used wood off ironmongery and other foreign inclusions; breaking finger joints and making trims to remove defects; removing of finish coating from the wood surface (varnish, paint); face planing; length cutting of the wood; double-edge profiling; trimming to size; glueing of variously-constructed GB; cutting of plywood, WPB and WFB; laying plywood or WPB on the core-board under pressure; cutting to size; sanding. To clear the used wood off the ironmongery conventional tools such as flat pliers, screwdrivers, nail pullers were used. In order to remove finishes from flat surfaces bench-type planer was used. The cleared wood was cut into strips of 17; 19 mm thick, and 22; 43; 63; 83 mm wide. The strips obtained were milled to width on the double surfacer planing machine to obtain strips of 20; 40; 60; 80 mm in width WPB were processed in a similar way. The obtained strips were bonded with PVA glue to get core-boards measuring 450 mm×450 mm and 350 mm×170 mm.

After glueing operation, the core-boards were dimension milled to thickness. Then we got cut-size plywood and WFB. A layer of plywood was pressed on the 350 mm×170 mm core-boards to get a GB of 22 mm thick. On the core-boards obtained and measuring 450 mm×450 mm×14 mm and 450 mm×450 mm×16 mm, plywood and WFB were pressed, respectively. The constructions of GB are shown in fig. 2.

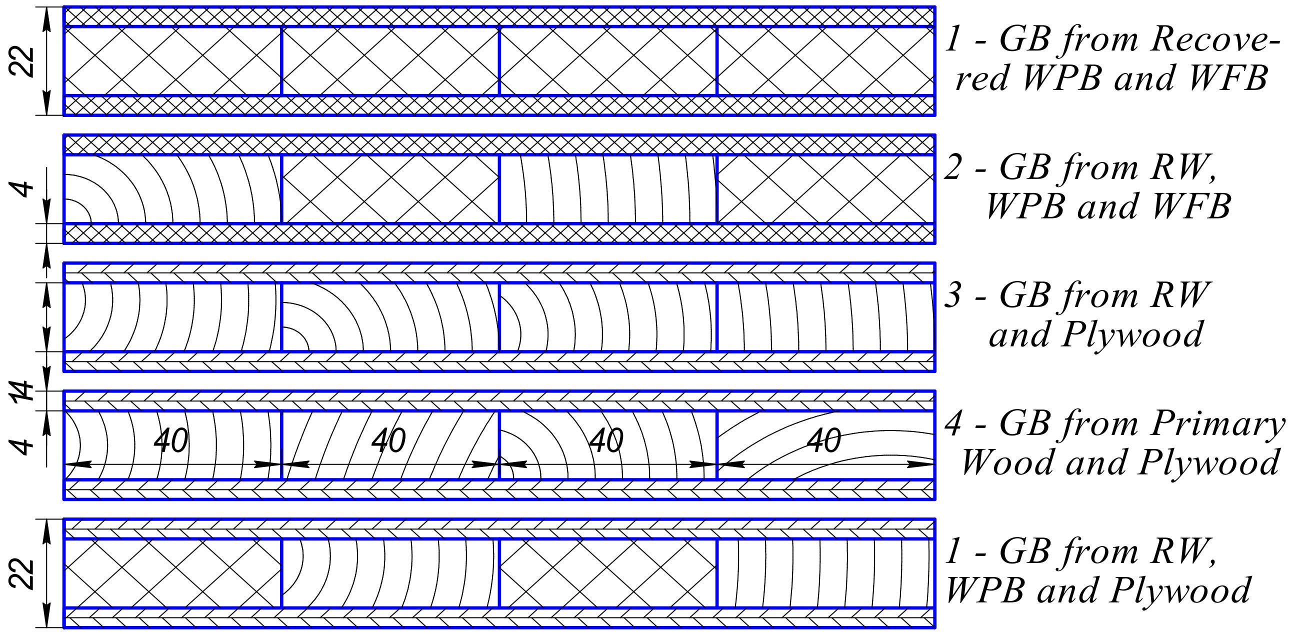


Fig. 2. Constructions of GB under investigation

Methods of preparing test specimens. Test specimens for determination of static bending strength across strips were made according to GOST 9625-87 which refers to GOST 13715-78. Specimens selection, their quantity, making and preparing for testing was done according to DSTU 9620. The specimen's thickness is equal to the thickness of the GB, that is 22 mm. The width of the specimen $\boldsymbol{b}$=50 mm, and, the length $\boldsymbol{l_1}$=15h=15·22=330 mm. When testing the specimens whose length $\boldsymbol{l_1}$=15h, the spacing between supports $\boldsymbol{l}$ is taken equal to $\boldsymbol{l}$=12h=12·22=264 mm.

Test specimens for determination of shearing dry strength along glue line, were made according to GOST 9624-93. Specimens selection, their fabrication and preparing for testing is done according to GOST 9620. The shape and dimensions of test specimens for determination of shearing strength along glue line should correspond to the 85 mm×40 mm×22 mm dimensions with the kerf of 5mm.

To suit GOST 9625-87 for measuring static-bending strength across strips the following guidelines must be followed: in order to determine static bending strength across strips the laboratory test machine УММ-05 (GOST 7855-61) was used while the test machine РМ-05 (GOST 28840-90) was used to determine shearing strength.

Static bending strength (σ_u) in MPa was calculated by the formula:

$$\sigma_u = 3P_{max}\, l/(2bh^2) \quad (1)$$

The strength along glue line τ_{sh} is determined in MPa by rounding the result to 0.05 MPa by the

$$\tau_{sh} = P_{max}/(b_{sh} l_{sh}) \quad (2)$$

where: P_{max} – maximum load, H; l – spacing between supports, mm; b – the width, mm; h – the specimen thickness, mm; b_{sh}, l_{sh} – the width and the length of the shear area, mm.

The results of research experiment on determination of static-bending strength of GB from RW at constant technological parameters. In the course of testing GB for static-bending strength across strips by the method described, we obtained data that are in agreement with the law of normal distribution, which was confirmed by Pirson's criterion and by superposition of the normal probability curve upon polygon of distribution (fig. 3). The mean value of static-bending strength across strips in the sample amounted to 19.88 MPa. To obtain the experimental results with an accuracy of 5 % and meaningful level of 95 % it is necessary that the number of observations during the main experiment should be equal to n=15.

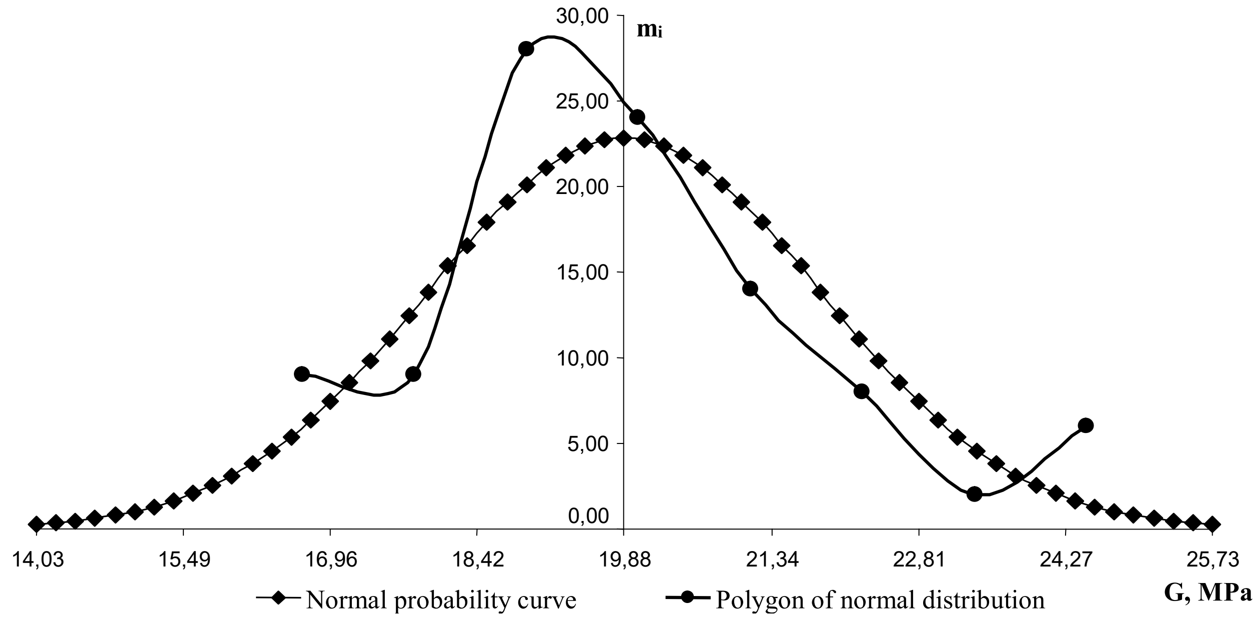


Fig. 3. The results of research experiment

The results of main experiment and comparative analysis of physical-and-mechanical properties of conventional GB and GB from RW. As a result of conducting the main experiments we obtained data on static-bending strength across strips for GB of other constructions including conventional GB (fig. 4).

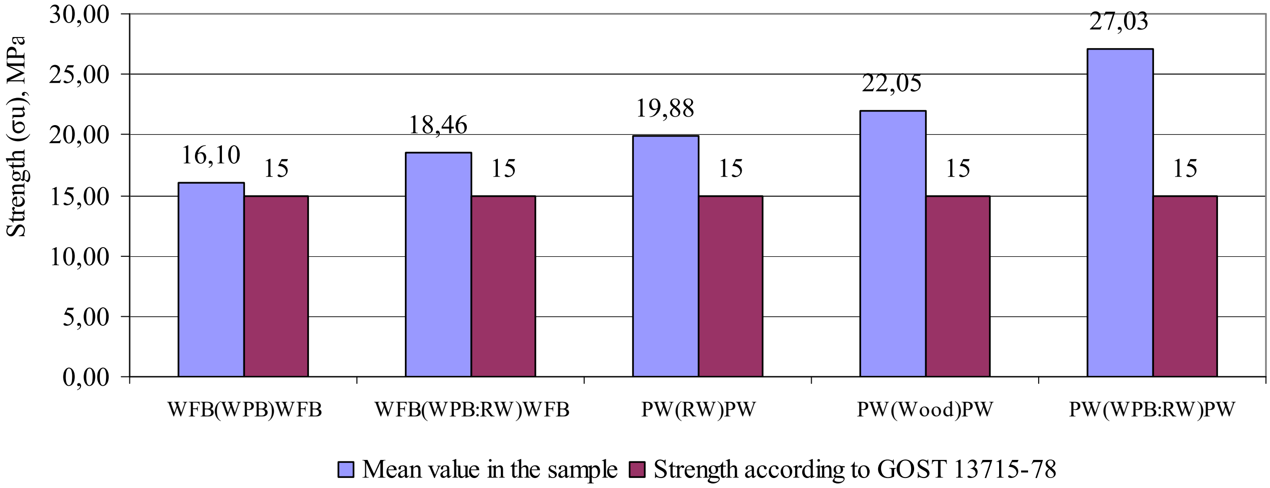


Fig. 4. Histogram of the GB (22 mm) static-bending strength across strips **(σ_u, MPa)**

As seen from the histogram in fig. 4 the least strong is the GB whose core-board is made from WPB in the jacket of WFB. Judging from the nature of the specimen breakage (fig. 5) this is accounted for low shearing strength of WPB of the core. Somewhat higher strength is demonstrated by the GB whose core-board is made from RW and whose jacket is from WPB. This is due to compensating for the low shearing strength of WPB in the core by high shearing strength of wooden strips. In its turn, the WPB partly makes up for the low static-bending strength of wood across grain. As seen from fig. 6, the weak point in this case is the low tension strength of WPB which has resulted in its breakage.

Fig. 5. Test specimen with a WPB core-board in the jacket of WFB at the moment of breakage

Fig. 6. Test specimen with a core-board made from RW and WPB, and in the jacket of WFB at the moment of breakage

High strength was shown by a veneered GB with the core-board made from RW. The cause of the specimen's breakage was a series of the plywood veneer plies breakage starting from the outer ply. The conventional GB demonstrated somewhat higher strength as compared with the GB made from RW. The character of breakage is similar to that of the RW from GB. The breakage was due to the plywood tear.

Fig. 7. Test specimen of veneered GB with the core-board from RW at the moment of breakage

The strongest was the veneered GB with the core-board made of RW and WPB. The mean value of this board strength makes up 27.03 MPa. In this case the breakage of the GB was initiated by emerging critical tension stresses in the WPB and their subsequent propagation onto the plywood resulting in the rupture of the latter (fig. 8).

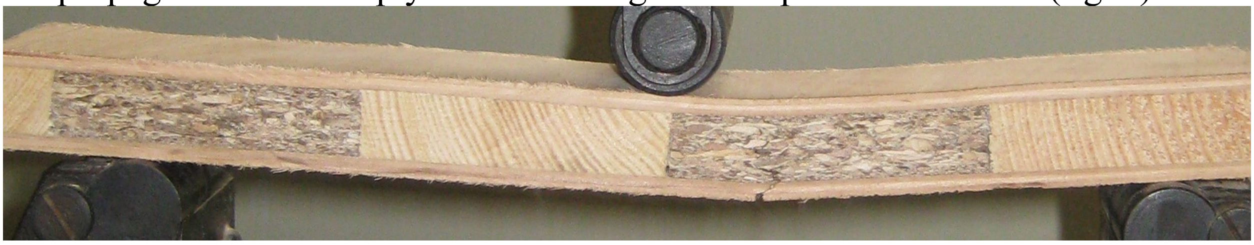


Fig. 8. Test specimen of a veneered GB with the core-board made of RW and WPB at the moment of breakage

Results and a comparative analysis of GB shearing dry strength along the glue line. The broken test specimens that had been used for determining static-bending strength, were used to fabricate new test specimens for determination of shearing dry strength along the glue line (fig. 9), the results being compared with the tabulated values ($\tau_{sh.table}$=1.0 MPa).

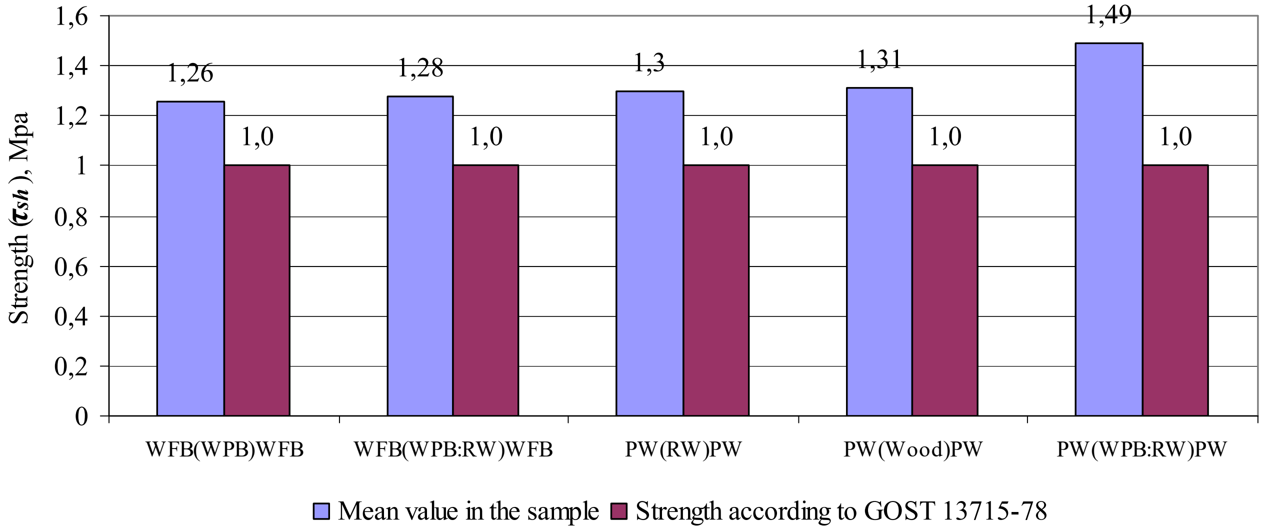


***Fig. 9. Histogram of GB shearing strength along glue line* (τ_{sh}, MPa)**

The breakage of GB with the jacket from WPB occurred as a result of shearing along the WFB layer irrespective of GB construction. The breakage of the veneered GB with bonded core-board of RW resulted from the wood rupture. The character of breakage of the veneered GB with the glued core-board of primary wood was the same. The breakage of the veneered GB with the core-board glued of RW and WPB took place mainly along the WPB. The highest strength 1.67 MPa was shown by the specimen in the kerf zone of which there was a WPB while the underside of the surface of shearing was reinforced at both ends with two pieces of wood measuring 9 mm. Again, the reason is that WPB tension strength is much higher than that of wood arcoss the grain, while shear strength of perpendicular to layers of wood is a little higher than shear strength of WPB along the core. Thus, the best physical-and-mechanical properties are found in veneered GB with glued core-board made of RW and WPB.

The study of influence of the strip width of GB and glue consumption upon the boards static-bending strength across the strips. These two parameters have not been chosen at random. The matter is that the recommendations as to the width of strips are somewhat different in GOST 13715-78 and DIN 68705-2-2003. According to GOST 13715-78 the width of the strip should not exceed its thickness by more than 2.5 times (this is needed to ensure the high shape stability of GB), whereas according to DIN 68705-2-2003 the width of the strip should not exceed its thickness by more than three times. Which standard we should keep to and how this influences the GB static-bending strength, has not been studied yet. As to adhesive used, it should be pointed out that conventional adhesives used for glueing GB have been phenolformaldehyde glues (GOST 20907-75) and ureaformaldehyde glues (GOST 14231-88). From the ecological line of reasoning, we chose PVA glue in order to investigate its influence on the GB static-bending strength.

The variable factors for implementation of B-plan were taken:

- the strip width $\boldsymbol{S}$, mm, thad varies within the limits of $20 < \boldsymbol{S} < 60$ mm;
- PVA glue consumption $\boldsymbol{Q}$, g/m^2, that varies within the limits $150 < \boldsymbol{Q} < 300$ g/m^2.

The constant factors in the investigation were as follows: relative air humidity of 60 to 65 % air temperature of 18 to 20 °C; atmospheric pressure of 736 mm of mercury column; air circulation velocity $\boldsymbol{v} \approx 0$ m/sec; air dust content; the room volume; PVA glue conditioning time; softwood blanks from RW; 4 mm-thick plywood; the same type of clamping device was used; blanks measuring 330 mm×50 mm×22 mm.

Foll factors plans involved allow to obtain linear dependence of the function of strength on the factors investigated. For most part of wood working processes, the representation like this would be inadequate. Therefore, other kinds of plan were used, that is plans by means of which one can obtain a mathematical description of objects in the form of polynom of the second order (quadratic model). At these plans, each factor $\boldsymbol{x_i}$ varies at three levels, that is it takes one of the three values in every test: the lowest $\boldsymbol{x_{imin}}$ the highest $\boldsymbol{x_{imax}}$ and the mean $\boldsymbol{x_{i0}}$. At normalized values, these levels are denoted respectively **-1, +1, 0**. Generally, the regression model for $\boldsymbol{k}$ variable factors will read:

$$y = b_0 + \sum_{i=1}^{K} b_i x_i + \sum_{i=1}^{K} b_{ii} x_i^2 + \sum_{i,u=1}^{k} b_{iu} x_i x_u \tag{3}$$

where $\boldsymbol{b_o}$ – free term; $\boldsymbol{b_i}$ – linear regression coefficients, $\boldsymbol{i=1, k}$; $\boldsymbol{b_{ii}}$ – quadratic regression coefficients; $\boldsymbol{b_{iu}}$ – pairwise coefficients, $\boldsymbol{u=1, k}$, $(\boldsymbol{i \neq u})$.

Having carried out statistical processing of experimental data we have the following regression equation:

$$y = 21.25 - 0.23x_1 - 0.50x_2 - 0.75x_2^{\ 2} \tag{4}$$

When analysing the regression equation, we can see that the factor $\boldsymbol{x_2}$, certainly, has the most influence on the output value of the function while factor's $\boldsymbol{x_1}$ influence is significantly less. Besides, output values grow up with an increase in $\boldsymbol{x_1}$ values, output values tend to decrease as factor's $\boldsymbol{x_2}$ value increases.

In order to determine equation coefficients in natural expression letus make use of factors coding formulas which we insert into the coded equation.

$$\sigma = 21.25 - 0.23 \cdot \frac{Q - 225}{75} - 0.50 \cdot \frac{S - 40}{20} - 0.75 \cdot \left(\frac{S - 40}{20} \right)^2 \tag{5}$$

Thus, the static-bending strength of GB is influenced the most by the strip width while glue consumption being of little influence; besides, the first factor influences in inverse proportion whereas the latter in direct proportion.

Graphical representation of experimental results. The influence of factors and their interaction upon the function of strength is best analyzed graphically where regression is presented in natural expression.

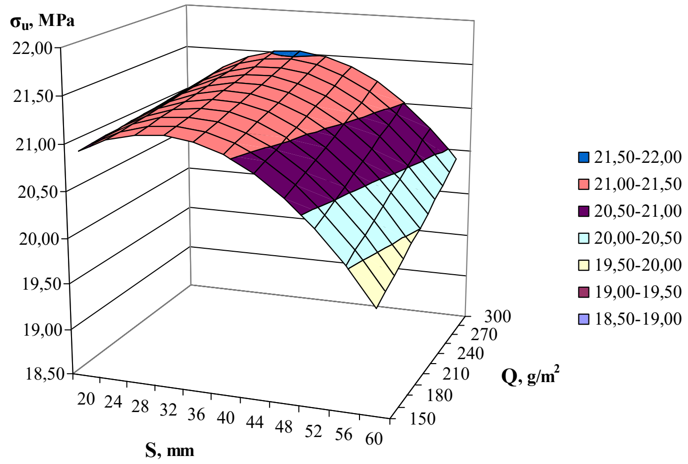


Fig. 10. Graphical dependence σ=f(Q, S)

When analyzing the graphical dependence we can see that the GB static-bending strength across strips is increasing within the range of 20 to 36 mm while further increase in the strip width leads to decrease in its strength. The dependence of the board's static-bending strength across strips upon glue consumption is of linear character, that is, the higher glue consumption, the higher strength. Also, it is evident that the influence of the strip width upon the GB static-bending strength is much greater that the effect of glue consumption. The maximum value of the GB static-bending strength amounts to 21.53 MPa with glue consumption of 300 g/m^2 and the strip width being 36 mm. As a result of optimization of the object under investigation by means of PC in the Microsoft Excel Environment, it is found that with the thickness of a strip n the core-board being equal to 14 mm, the recommended strip width for the core-board makes up 35.36 mm. Consequently, the ratio of the width to thickness of strips amounts to 35.36/14=2.52, which practically coincides with that recommended by GOST 13715-78 1/2.5.

Conclusions:

1. Physical-and-mechanical properties of GB made from RW have rather a high scattered field, nevertheless, they are subordinated to the law of normal distribution, which was confirmed by Pirson's criterium when analyzing the sample of one hundred specimens tested for static-bending strength across strips according to GOST 9625-87.
2. Physical-and-mechanical parameters of all GB irrespective of their construction meet GOST 13715-78 requirements.
3. The highest level of physical-and-mechanical properties are found in veneered GB with the glued core-board made from RW and WPB. The average value of static-bending strength across strips of this board makes up 27.03 MPa, while the shearing dry strength along glue live is 1.49 MPa.
4. The lowest values of physical-and-mechanical properties are found in the GB with glued core-board from WPB and in the jacket made of WFB. The average static-bending strength across strips makes up 16.10 MPa while the shearing dry strength along glue line makes up 1.26 MPa.
5. Physical-and-mechanical parameters of conventional veneered GB with glued core-board made of primary wood are a little higher than those of GB of similar construction with glued core-board made of RW. Thus, the static-bending strength across strips of conventional GB makes up 22.05 MPa whereas the strength of GB from RW makes up 19.88 MPa. The shearing strength along glue line of conventional GB amounts to 1.31 MPa while the strength of GB from RW makes up 1.30 MPa.
6. According to GOST 13715-78 the recommended strip width should not exceed its 3-fold thickness. Common glues used for glueing GB are phenolformaldehyde (according to GOST 20907-75) and urea-formaldehyde (according to GOST 14231-88) but in our investigation we used PVA glue as an alternative. Therefore it was decided to study using the method of mathematic modelling how the ratio between strip's size and glue consumption influences the static-bending strength across strips.

7. The regression model obtained is adequate and, consequently, can be used to describe the object under investigation.

8. To optimize the investigation object it was chosen to use PC. As a result of the optimization it was found that the maximum static-bending strength of GB across strips can be achieved with the following parameters: strip thickness is 22 mm; strip width – 35.36 mm, and recommended glue consumption is 300 g/m^2.

Practical advice and guidelines: To obtain shape stability and maximum static-bending strength of GB across strips it is recommended that the width of the strips used for bonding a core-board from RW, should not exceed its 2.5 – fold thickness. To obtain a GB whose physical-and-mechanical properties meet GOST 13715-78 glue consumption should be of 150 g/m^2.

1. To increase the volume output with RW it is better to use strips of 60 to 80 mm in width unless high shape stability of GB is required. To ensure high shape stability of GB during manufacturing a core-board from RW and WPB, it is necessary to use wooden strips of radial cut. GB with core-board from WPB in the jacket of WFB as well as GB with core-board made from RW and WPB in the jacket of WFB, are recommended to use for making carcasses of upholstered furniture and for door panels.
2. Veneered GB with bonded core-board from RW are recommended for making cabinets. Veneered GB with core-board from RW and WPB are recommended for use where high static-bending strength across strips is required.

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Порівняльний аналіз фізико-механічних параметрів столярної плити із вживаної деревини різних конструкцій

Розглянуто основи класифікації, методи очищення та методи переробки вживаної деревини (ВЖД). Запропоновано переробляти ВЖД на столярну плиту (СП). Проведено порівняльний аналіз фізико-механічних параметрів традиційної СП та плит із ВЖД різних конструкцій. Створено регресійну модель для прогнозування міцності СП на статичний згин впоперек рейок товщиною 22 мм в залежності від ширини рейки щита та витрати клею.

1. Фізико-механічні властивості СП із ВЖД мають досить високе поле розсіювання, тим не менше, вони піддаються закону нормального розподілу, що було підтверджено критерієм Пірсона під час аналізу вибірки із ста взірців випробуваних на міцність при статичному згині впоперек рейок згідно ГОСТ9625-87. Фізико-механічні параметри всіх СП не залежно від їх конструкції задовольняють вимоги ГОСТ13715-78.
2. Найвищими фізико-механічними параметрами характеризується фанерована СП з клеєним щитом із ВЖД та ДСП. Середня міцність на статичний згин впоперек рейок такої плити становить 27,03 МПа, а міцність на сколювання по клейовому шарі в сухому стані 1,49 МПа. Найнижчими фізико-механічними показниками характеризується плита з клеєним щитом із ДСП в сорочці з ДВП. Середня міцність на статичний згин впоперек рейок такої плити становить 16,10 МПа, а міцність на сколювання по клейовому шарі в сухому стані 1,26 МПа.
3. Фізико-механічні параметри традиційної фанерованої СП з клеєним щитом з первинної деревини дещо вищі від фізико-механічних параметрів аналогічної за конструкцією СП з клеєним щитом з ВЖД. Так міцність на статичний згин впоперек рейок традиційної СП становить 22,05 МПа, а міцність СП із ВЖД становить 19,88 МПа. Міцність на сколювання по клейовому шарі традиційної СП становить 1,31 МПа, а СП із ВЖД 1,30 МПа.
4. Згідно ГОСТ 13715-78 рекомендована ширина рейки не повинна перевищувати 2,5 її товщини, а згідно DIN 68705-2-2003 ширина рейки не повинна перевищувати її товщину більше, ніж в 3 рази. Традиційно для склеювання СП використовують клеї на основі фенолформальдегідних смол за ГОСТ 20907-75 і мочевиноформальдегідних смол за ГОСТ 14231-88, а для досліджень альтернативно був взятий клей ПВА. Тому було вирішено дослідити вплив співвідношення сторін рейки та витрати клею на міцність СП на статичний згин впоперек рейок, методом математичного моделювання. Отримана регресійна модель є адекватною, а отже може бути використана для опису об'єкта дослідження. Для оптимізації об'єкту досліджень було вибрано метод оптимізації за допомогою ПК. В результаті оптимізації для досягнення максимальної міцності СП на статичний згин впоперек рейок товщиною 22 мм рекомендована ширина рейки складає 35,36 мм, рекомендована витрата клею складає 300 г/м^2.

Практичні рекомендації:

1. Для досягнення формостійкості та максимальної міцності СП на статичний згин впоперек рейок, рекомендується ширину рейки для склеювання столярного щита із ВЖД приймати не більше 2,5 її товщини. Для отримання СП, фізико-механічні властивості якої відповідають ГОСТ 13715-78, достатньо наносити клей з витратою 150 г/м^2. Якщо висока формостійкість плити не потрібна, для збільшення об'ємного виходу з ВЖД доцільно використовувати рейки шириною до 60-80 мм. Під час виготовлення щита з ВЖД та ДСП для забезпечення високої формостійкості СП необхідно використовувати дерев'яні рейки радіального перерізу.
2. Плиту з щитом з ДСП в сорочці з ДВП, як і плиту з щитом з ВЖД та ДСП в сорочці з ДВП рекомендовано використовувати для виготовлення каркасів м'яких меблевих виробів та дверних полотен. Фанеровану СП з клеєним щитом із ВЖД рекомендовано використовувати для виготовлення корпусних меблевих виробів. Фанеровану СП з клеєним щитом з ВЖД та ДСП рекомендовано використовувати там, де необхідна висока міцність на статичний згин.

Ключові слова: деревина, вживана деревина, столярна плита, деревностружкова плита, деревоволокниста плита, фанера, підготовлена вживана деревина, перероблення відходів, поводження з відходами.