3. **Gayda S.V., Voronovich V.V.** (2011): *Issledovanie osobennostey gnut'ya vtorichno ispol'zuemoy drevesiny* [Investigation of the features of bending of post-consumer wood]. *Scientific progress – creative young: proceedings of the International Scientific Conference, Mari State University*: 190-192 (in Russian).

4. **Kozachenko G.V., Pogorelov Y.S., Hlaponov L.Y., Makuhin G.A.** *Upravlinnya zatratami pidpriємstva* [Management costs of the company]. – Monograph. – Kyiv: Libra, 2007. – 320 p.

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Техніко-економічний аналіз способів виготовлення криволінійних заготовок

Проаналізовано способи отримання криволінійних заготовок. Для порівняння вибрано чотири варіанти технологічного процесу: випилювання криволінійних заготовок із склеєного на гладку фугу щита; випилювання криволінійних заготовок із ділянок, склеєних по довжині на зубчатий шип по формі заготовки; гнуття масивної деревини; гнуття з одночасним склеюванням. За основу розрахунків вибрано криволінійну заготовку, розраховано потребу в сировині і матеріалах, розроблено технологічні процеси, розраховано потребу в енергоносіях, розраховано економічну ефективність кожного варіанта. Доведено пріоритетність виготовлення криволінійних заготовок гнуттям масивної деревини за рядом критеріїв.

Ключові слова: деревина, гнуття, криволінійні заготовки, технологія, аналіз.

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THE STUDY OF THE BLOCKBOARD SHAPE STABILITY DEPENDING ON THE DESIGN

The existing designs of blockboards are analyzed. Experimentally investigated was the influence of the core structure of blockboard and methods of joining its elements on the shape stability and dimensional change after the manufacture.

Keywords: wood, blockboard, core, structure, shape stability.

Relevance of the problem. Currently, manufacturers of panel-form materials are developing new materials for the purpose of obtaining various designs, environment-friendly and with the possibility of expanding the scope of application. However, the ordinary blockboards (coreboards), which are often used, for example, for the manufacture of the door leaf, do not become irrelevant.

One of the problems in the production is to ensure the dimensional stability and shape of the blockboard, which is important during its operation.

The purpose of the study was to determine the characteristics which are important during operation – warping and waviness – depending on the design of the blockboard.

Studies were conducted to determine the shape stability of such boards for various design options, as well as calculations were made to determine the economic feasibility of manufacturing such material. The object of the study was a blockboard – panel of strips (block), sandwiched between two layers of rotary-cut veneer.

Analysis of the research and publications. Despite the variations in colour and texture offered by manufacturers of laminated chipboard, modern furniture design dictates fashion for style solutions. This can be, for example, large working surfaces of a large thickness. There is a growing demand for lightweight construction materials, allowing to significantly reduce the use of wood and logistical costs of the furniture parts

and ready-to-use furniture. This encourages the active development of panel-form materials with different types of core [3, 5, 10, 12].The use of "forgotten" panel-form materials of a frame structure with different types of core in the manufacture of cabinet-type furniture allows obtaining the properties of a perfect surface, high surface hardness and impact resistance. With modern adhesive materials and high-precision equipment, you can create panel structures from natural wood of the desired configuration and thickness. In addition, such designs are environment-friendly since they contain significantly less amount of harmful emissions from adhesives as compared to laminated and faced wood particleboards.

Blockboard is a product that has been present in our market for a long time. It is used for the manufacture of furniture, doors, partitions, floors, and sometimes walls in residential buildings, car-building, shipbuilding and other industries. With today's shortage of wood resources, it is important to use post-consumer wood in the production of blockboards [1-10]. A classical blockboard consists of strips glued together (the bulk of blockboard), faced with 3 layers of veneer – two rotary-cut-veneer layers, glued perpendicular to each other, and the outer ply is made of sliced veneer. If the boards are not faced with sliced veneer, then there are only 2 layers of rotary-cut veneer over the bulk.

Blockboard is traditionally considered to be the best material for manufacturing high-quality furniture. It is durable and lightweight structural material. Blockboards are environmentally benign in production and application.

This type of panel-form material was the main substitute for solid wood in the manufacture of furniture products, but with the development of wood particle- board production, its share in furniture making significantly decreased. One of the disadvantages of blockboards is the change in dimensions and shape after fabrication. The indexes of shape stability are different for different designs, but the blockboard of type NR (HP) [14] , with the core composed of strips which are not glued edge-to-edge, shall be considered as having the greatest shape stability. However, the blockboards of this type are the least strong, the strips, during the manufacture of the blockboard, are connected with a twine for fixation, the strength of the blockboard is provided only by adhesive bonding ‘ strip – veneer facing’.

Blockboards of types SR (СР) and BR (БР) have better indexes of strength [13, 14], due to glueing of the core strips by edge to edge. Here the core strips form a solid basis, and in combination with facing – a rugged structure. Warping of such panels is higher than that of panels NR (HP).This is due to the mutual deformation of the core strips, glued to form a blockboard. The warpage rate depends on the relative position of the annual rings in adjacent strips, the slope of grain, the presence of defects, etc.

The problem of shape stability has been solved in various ways, in particular, the methods proposed in the patent by V. Pyatkov, A. Voyakin “A method of manufacturing blockboards“ [11].

The performance of this task is ensured by the fact that, before laying the blockboard, the adjacent strips of the basis are fastenedby brackets on the upper and lower planes. Fig. 1 shows the structure of a blockboard using steel brackets.

The blockboard core is formed from thickness-calibrated strips 1. The adjacent strips in the core are fastened by brackets on the upper and lower planes 2 at a certain distance from the end of the core. Then the core is sandwiched between two layers of sheet wood material 3, for which can be used natural veneer, plywood, synthetic veneer,

fibreboard. The core is placed between layers of sheet wood material whose surfaces, adjacent to the core, are coated with adhesive ,with the subsequent retention of the formed blockboard in the press.

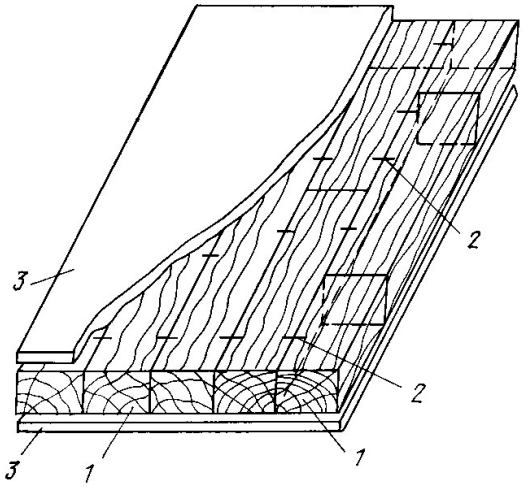


Fig. 1. A method for manufacturing a blockboard by fastening strips with steel brackets: *1 – core strip; 2 – steel bracket; 3 – facing*

This method of manufacturing blockboards, according to the authors [2], allows obtaining a blockboard with greater rigidity, compared to blockboards of type NR (HP), and with the preservation of its shape stability. Jointing of adjacent strips with brackets simplifies the technology of manufacturing a blockboard since there is no gluing operation of strips compared to the production of a blockboard of type NG (НГ).

Methods of the studies. The study of the blockboard shape stability, depending on the design, was carried out according to the following procedure:

Blockboard design. The basis (core) of blockboards was made of softwood strips, 450 mm long, 19 mm thick, and 20, 40 and 60 mm wide.

Facing – rotary-cut veneer, birch, 1.15 mm thick. Adhesive – PVA dispersion, class D3. The glue was applied manually with a glue spread of 150-200 g/m^2.

The fabricated specimens of blockboard were 450×450 mm in size, with three widths of core strips for three design types of blockboard. The study was conducted at the training and production workshop of the Department of furniture production techniques and wood products of the UNFU.

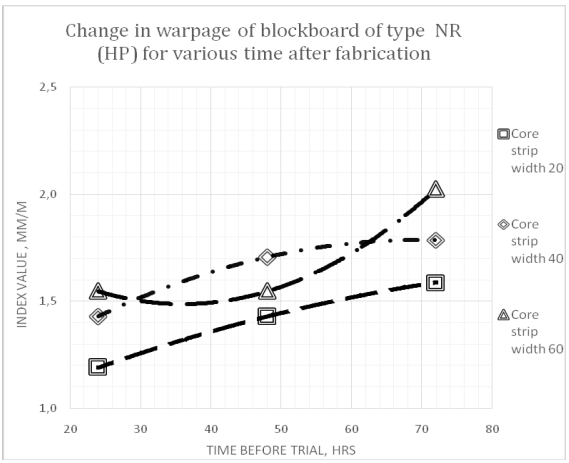
The length, width and thickness of the blockboards, waviness and warpage were controlled according to the requirements [13, 14].

Results of the studies. The research was conducted by monitoring the blockboards' parameters 24, 48 and 72 hours after the blockboards were unloaded from the press. As it turned out, after the processing the experimental data, the deviation in the values for shape stability (waviness and warpage) is observed for different core strip widths and this is influenced by the blockboard designs.

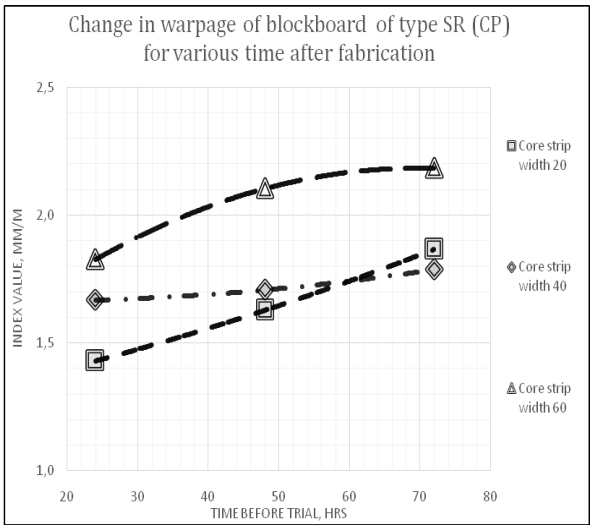
As follows from the experiments, the blockboard of type NR(HP) can be considered the best in terms of shape stability. This blockboard is made of strips that are not glued together and its strength is provided only at the expense of the adhesive jointing: the core strip face–veneer facing. This design, due to the fact that the core strips are free in the transverse direction, enables war page of the blockboards. Such a design is incon-

venient in manufacturing as it requires additional effort when pressing the blockboard – the strips need to be fixed in the transverse direction.

The application of adhesive on the side surfaces of core strips improves the strength of the blockboard. However, this leads to an increase in deformation of the blockboard due to stresses, changes in humidity, the presence of defects in strips, incorrect stacking, etc. The third type of blockboard was a design in which the core strips were fast end with one another by using steel brackets as described in [14].



a)



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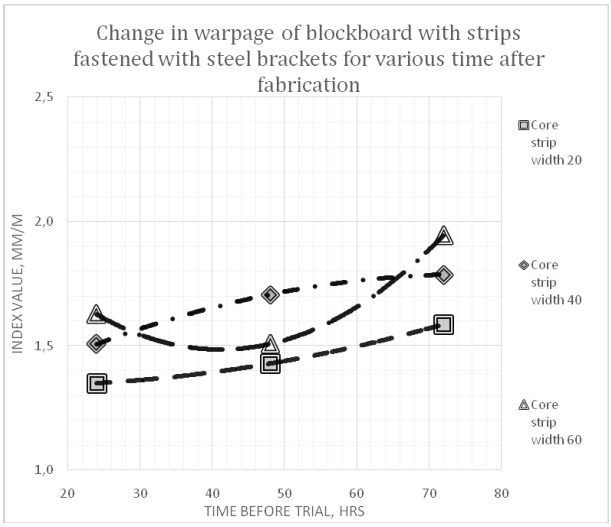

c)

Fig. 2. Warpage change in time for different types of blockboard:
a – for blockboard of type NR(HP) , b – for blockboard of type SR (CP), c – for a blockboard in which the core strips are fastened with brackets

Conclusions:

1. As shown by the experiments, fastening the core strips with steel brackets has a positive impact on the properties of the blockboard. In particular, the core will be sufficiently rigid and does not require transversal clamping when pressing.
2. In terms of shape stability, this blockboard is not inferior to the blockboard of type NR (HP) with non-glued strips.
3. The amount of warpage for the above mentioned blockboard designs is the smallest for blockboards of type NR (HP)and with fastening brackets is 1.78 and 1.79 mm/m, respectively, for the width of core strip 40 mm.
4. Thus, the studies have shown that the design with fixed core strips can be applied to the manufacture of blockboards.

5. Calculations of manufacturing costs to produce one square meter of blockboard for three design options with different core strip widths showed that the largest amount of material costs is for blockboards with brackets and the blockboard of type NR (HP) is the cheapest.

References

1. **Gayda S.V.** (2017): *Tekhnologiya i svoystva mebel'nogo shchita iz vtorichno ispol'zuemoy drevesiny* [A technology and properties of furniture board made of post-consumer wood]. *Actual problems of forest complex* 48:34-38, (in Russian).
2. **Gayda S.V.** (2016): A investigation of form of stability of variously designed blockboards made of post-consumer wood. *ProLigno* 12(1):22-31.
3. **Gayda S.V.** (2016): *Formoustoychivost' stolyarnykh plit iz vtorichno ispol'zuemoy drevesin* [A form of stability of blockboards made of post-consumer wood]. *Actual problems of forest complex* 46:148-153, (in Russian).
4. **Gayda S.V.** (2015): *Issledovanie fiziko-mekhanicheskikh svoystv vtorichno ispol'zuemoy drevesiny* [Investigation of physical and mechanical properties of post-consumer wood]. *Actual problems of forest complex* 43:175-179, (in Russian).
5. **Gayda S.V.** (2015): *Tekhnologiï i fiziko-mekhanichni vlastivosti stolyarnikh plit iz vzhivanoï derevini* [Technology and physical and mechanical properties blockboard made of post-consumer wood]. *Technical service of agriculture, forestry and transport systems* 3(1):145-152, (in Ukrainian).
6. **Gayda S.V.** (2015): *Tekhnologicheskie osnovy pererabotki vtorichno ispol'zuemoy drevesiny* [Technological of processing basics of post-consumer wood]. *Actual directions of Scientific Research XXI century: Theory and Practice, Voronezh State Forestry Engineering University Named after G.F. Morozov* 3(8-2 (19-2)): 82-86, (in Russian).
7. **Gayda S.V.** (2015): Modeling properties of blockboards made of post-consumer wood on the basis of the finite element method. *Forestry, Forest, Paper and Woodworking Industry* 41:39-49.
8. **Gayda S.V.** (2013): *Tekhnologiï ta rekomendatsiï do vikoristannya vzhivanoï derevini v derevoobroblenni* [Technologies and recommendations on the utilization of post-consumer wood in woodworking industry]. *Forestry, Forest, Paper and Woodworking Industry* 39(1):48-67, (in Ukrainian).
9. **Gayda S.V.** (2013): *Resursooshchadni tekhnologiï pereroblennya vzhivanoï derevini* [Resource-saving technologies of recycling of post-consumer wood]. Scientific Bulletin of NULES of Ukraine: *Technology and Energy of agroindustrial complex* 185(2):271-280, (in Ukrainian).
10. **Gayda S.V.** (2010) A comparative analysis of physical and mechanical parameters of variously designed glued boards made of post-consumer recovered wood. *Forestry, Forest, Paper and Woodworking Industry* 36:81-92.
11. **Goncharov N.A., Voyakin A.S.** (12.08.2002) *Sposob izgotovleniya stolyarnoy plity* [A method of manufacturing blockboards] (19) RU (11) 2214328 (13) C1. Application: 2002121261/13, *Moscow State University of Forestry*, (in Russian).
12. **Kushpit A.S., Mnykh A.Ya., Kushpit O.M.** (2012) *Zastosuvannya shchitiv zi stil'nikovim zapovnennyam u meblevomu virobnitstvi* [Application of blockboards with honeycomb core in furniture production]. *Scientific Bulletin of UNFU* 22(6): 90-96, (in Ukrainian).
13. **DIN 68705-2:2014-10** Plywood – Part 2: Blockboard and laminboard for general use. Germany, (in Deutsch).
14. **GOST 13715:1978** *Plity stolyarnye. Tekhnicheskie usloviya* [Blockboards. Technical specifications]. *Moskow: Publishing house of standards*, (in Russian).

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Аналіз формостійкості столярної плити залежно від конструкції

Проаналізовано існуючі конструкції столярних плит. Експериментально досліджено вплив будови заповнення столярної плит та способів з'єднання її елементів на стабільність, формостійкість та зміну розмірів після виготовлення.

Ключові слова: деревина, столярна плита, заповнення, конструкція, формостійкість.