

Review Article

**THE DEPENDENCE OF PHYSICO-MECHANICAL PROPERTIES OF WOOD-PLASTIC COMPOSITE PLATE MATERIALS FROM THE CONTENT OF POLYMER BINDER**

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**Abstract.**

This article presents the results of research on the dependence of the physical and mechanical properties of composite wood-plastic plate materials on the content of polymer binders. It was found that the optimal physical and mechanical properties of composite wood-plastic plate materials are observed when the polymer binder content is 14-16%.

**Keywords:** composition, wood-plastic materials, polymer binders, bast fibers, cotton stems, tensile strength, hardness, modulus of elasticity, water absorption, swelling.

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**INTRODUCTION**

It is known that the strength of manufactured boards based on cotton stems is determined not only by the quality and quantity of the binder, but also by the mutual contact between the binders and the filler particles. In this regard, many scientists have studied the effect of the polymer binder on the properties of slabs made of cotton stems. However, their work did not consider the effect of the polymer binder on the properties of plates at different chip fractions. Since the small fraction of chips has a large specific surface area and to cover the entire surface requires a greater consumption of binder. Best fibers can also be classified as small-fraction shavings in the sense of their large specific surface area, since in the crushed and loosened state they are thread-like fibers with a diameter of 0.05-0.3 mm. These factors require a separate study of the influence of the binder content on the properties of cotton stalk plates.

Depending on the brand of plates produced, the nature of the filler, its porosity, the ability to absorb resin, the shape and size of the chips, a certain amount and quality of the binder is required. The binder for single-layer, as well as for multi-layer plates, should be distributed evenly in order to get the plates with the maximum strength at the minimum content. Cotton stems used for the production of slabs have a large specific surface area due to the presence of fibers in them. As a result, the amount of binder used will differ from the polymer applied in the production of wood boards.

In connection with the above, the binder must be applied in the form of drops in a uniform layer with a spray gun with an air pressure of 0.8-1 ATM. The binder becomes more effective if it is applied to a surface with intact cotton stem fibers. At the same time, better particle adhesion is obtained at a lower pressure. For less loosening of bast fibers in order to reduce the specific surface of the filler and therefore the consumption of the binder, mixing with the binder was carried out for 5 minutes.

The most important factor is the degree of use of the binder, regardless of the type of plate. The properties of the slab reflect the quality and quantity of bonds formed between the binder and the wood. As the binder content increases, the properties of the slab improve until it fills all the voids. However, it was found that an increase in the binder content is not always favorable, primarily from an economic point of view, i.e. a minimum consumption of the binder is required.

The effectiveness of the binder is not the same in the manufacture of plates of different densities. This is confirmed by the results of research conducted in the laboratory.

For rational use of the binder, it is important to know the optimal content of the binder on the various layers of slabs to obtain multi-layer slabs from cotton stems. In this case, small fractions ( ), can be used for the outer layers, and large fractions ( or bast fibers) can be used for the inner layer.

In this regard, determining the optimal content of the polymer binder is in demand and relevant.

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**OBJECT AND METHOD OF RESEARCH**

The objects of study as a binder was chosen as urea resin, and the filler is selected shaving mass from the stems of the cotton plant.

In order to determine the degree of influence of the polymer binder on the quality of the plates, chip masses with different binder content were prepared: 4, 6, 8, 10, 12, 14, 16, 19, 20 %, (from the weight of the chip to the dry residue) for each type of chip. Three batches of plates were obtained: I-plates made of cotton stem particles of the 10/1,5 fraction; II-from cotton stem particles of the 1.5/0 fraction; III - plates made of bast fibers of the 0/10 fraction [1].

Chips for plates with a small fraction (1.5/0) were obtained in this way thus: the chips crushed in a laboratory drum shredder were sifted through a sieve with square cells of 1,5x1,5 mm in size. Chips for plates with a large fraction (10/1,5) were obtained by selecting the chip mass that passed

through a sieve with 10 mm cells and remained on a sieve with 1.5 mm cells.

Bast fibers were obtained by screening the chip mass from the cotton stems through a sieve of 10 mm. at the same time, the chip mass consisting of 90% of bast fibers and 10% of lignified particles remained in the sieve at the descent, which were then moved manually.

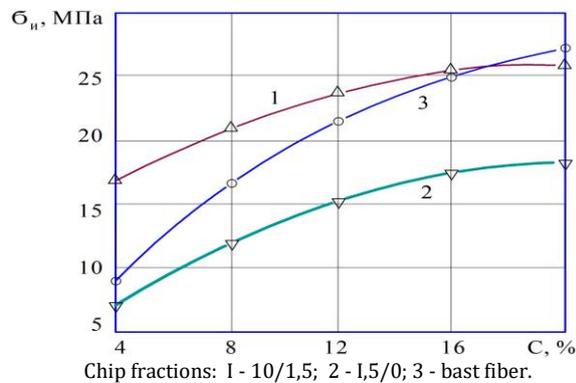
For stability of the chip fraction composition in all samples were added 10 % of the weight of the main chip fraction of the 0.65/0 fraction.

The plates were pressed in single layers with the calculated density 750 kg / m<sup>3</sup>, and the other conditions and methods for producing slabs were similar to those described in [2]. The physical and mechanical properties of the developed composite wood-plastic plate materials were determined by well-known methods used in the CIS countries [3].

**RESEARCH RESULTS AND THEIR ANALYSIS**

The influence of the binder content was tested using seven criteria: bending and tensile strength, Flexural modulus, hardness, specific resistance to nail pulling, water absorption, and swelling. The choice of these criteria is explained by the fact that the content of the binder directly affects all these factors. Therefore, taking into account all the above factors, the minimum required binder content was determined in the manufacture of composite wood-plastic plate materials, raw cotton particles.

Studies have shown that the strength of composite wood-plastic boards obtained from 10/1.5 shavings during bending and stretching, depending on the amount of binder (4-20%), first increases from 17.5 to 25.5 MPa when bending and from 0.42 to 1.0 MPa when stretching. At the same time, the intensity of the strength increase decreases after 12-14% of tarring [4] (Fig.1).

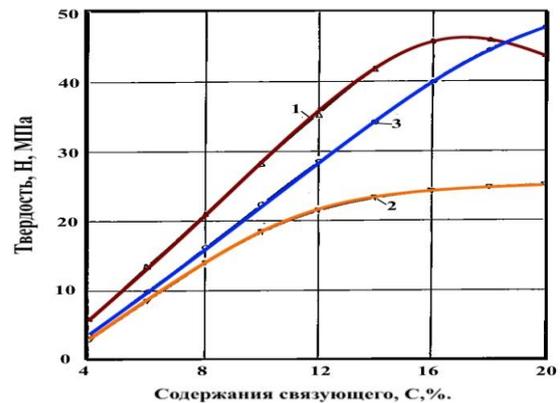


**Rice. 1. Dependence of the bending strength of composite wood-plastic plate materials on the binder content**

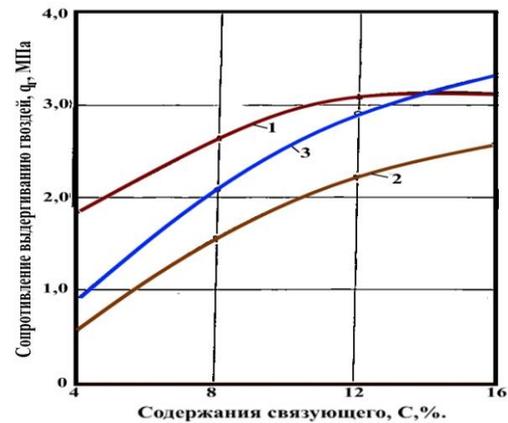
This is mainly due to the fact that at 14% of the binder, all the voids between the chips are filled with resin and the bonding area is maximum. The further decrease in the intensity of the growth of the bending and tensile strength is due to excess moisture in the package, as a result of which the vapor-gas pressure weakens the contact of particles in the inner layers at the moment of opening the press plates. In addition, when the binder content is 14%, the gap occurs not only at the chip-chip interface, but also inside the particles. Therefore, a further increase in the binder content does not have a noticeable effect on the bending and tensile strength (Fig.1).

Hardness (Fig. 2) and the modulus of elasticity (Fig. 3) it stabilizes when the binder content is 16 and 12%, respectively. These indicators characterize the properties of only the outer layer of the composite wood-plastic plate, so the more it is tarred, the harder it is, and the properties of pulling out nails

are explained by the same reasons as when bending and stretching.

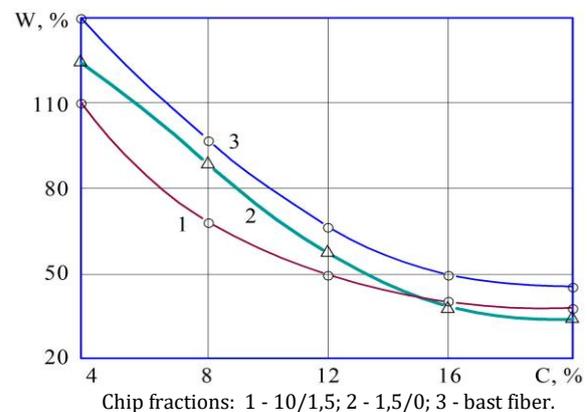


**Rice. 2. Dependence of the hardness of composite wood-plastic plate materials on the binder content.**

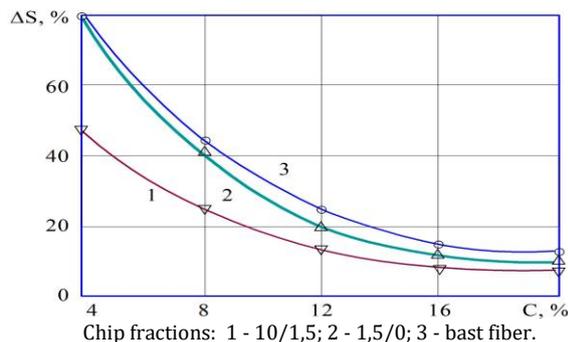


**Rice. 3. Dependence of the modulus of elasticity of composite wood-plastic plate materials on the binder content.**

Properties of these plates for water absorption (Fig. 4) and swelling (Fig.5) intensively reduced to a binder content of 16 % and then also stabilized. This is due to the fact that when the binder content is more than 16% due to excess moisture in the package, the vapor-gas pressure weakens the contact of particles and internal cracks can form, and this contributes to the penetration of water into the core of composite wood-plastic plates.



**Rice. 4. Dependence of water absorption of composite wood-plastic plate materials on the binder content**



**Rice. 5. Dependence of swelling of composite wood-plastic plate materials on the binder content.**

Analysis of the above-mentioned physical and mechanical properties of plates (fraction 10/1, 5) shows that they meet the requirements of GOST 10632-89 with a minimum binder content of 10 % at a density of 750 kg / m<sup>3</sup> and can be used for the inner layers of composite wood-plastic plates. For plates with improved physical and mechanical properties, it is advisable to take a binder content of 12-14%.

Studies have shown that the mechanical characteristics of plates obtained from small fractions (1.5 / 0) and bast fibers increase with an increase in the binder content from 16 to 20 %, and the growth rate decreases slightly when the binder content is more than 16 %.

The same pattern is observed when testing for water absorption of composite wood-plastic plate materials and swelling.

#### CONCLUSION

It was found that when the binder content is 16 %, all the voids between the particles are filled and the bonding area is maximum. In this case, the destruction of samples when stretched perpendicular to the formation occurred mainly between natural layers of bast fibers or particles. Analysis of the results of research on the physical and mechanical properties of composite wood-plastic slabs from these fractions shows that they satisfactorily meet the requirements of GOST 10632-89 with a minimum binder content (12-14%), and a density of 750 kg/m<sup>3</sup>. To obtain a plate with improved properties, it is advisable to take the binder content of 16%.

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