

Investigation of changes in qualitative characteristics of gypsum-fiber sheets, depending on fiber type used

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Abstract. In the article the popular finishing material for civil construction, gypsum-fibrous boards, is considered. The importance of using fireproof materials in construction is discussed. The mechanism of resistance of known types of gypsum-fibrous boards to fire burning is considered. A method is proposed for improving the quality characteristics of gypsum-fibrous boards by replacing the currently used paper fiber with mineral or polymeric ones. It was suggested that it is possible to increase the fire resistance of gypsum-fibrous boards by the introduction of incombustible asbestos fibers. The properties of gypsum-fibrous boards with a full or partial replacement of paper fibers on glass fiber, basalt fiber, asbestos fiber and polymeric fibers have been studied. Densities, surface water saturation, coefficient of thermal conductivity and strength characteristics of boards were investigated, based on the developed compositions. The expediency of using asbestos fiber as a fiber for the production of gypsum-fibrous boards is established.

1. Introduction

Providing of fire safety is one of the primary tasks in modern construction. The primary measure to combat the spread of fire in the room is the use of specialized fire-resistant materials [1-8].

A universal finishing material with increased strength and resistance to fire is a gypsum-fiber boards (GFB), which is a sheet finishing material made of gypsum binder, reinforced with paper fibers throughout the volume. The presence of crystallization water in the structure of the hardened gypsum stone requires, when heating the heat costs for dehydration. In addition, the evaporating water blocks the access of oxygen to the combustion zone. In addition, the even more porous structure of the material formed during dehydration provides its higher thermal resistance [9-13].

Nevertheless, this is not enough, and therefore, in a number of cases, special flame retardant additives are introduced into the gypsum-fibrous mixture, which provide the product with an increased fire resistance. In addition, to increase fire resistance, non-flammable materials, for example basalt fiber, replace organic fillers [14].

Replacement of organic paper fiber with mineral fiber will not only increase the fire resistance of products, but also increase their strength in bending, resistance for biocorrosion and durability [15].

The most suitable type of fiber for this purpose are chrysotile-asbestos fibers. It is known that asbestos has a high fire resistance and is used in compositions where a combination of flexibility and heat resistance is necessary [16-18]. In addition to asbestos fibers, it is also acceptable to use basalt, polypropylene and glass fibers as fibers.



The purpose of this work is to identify the effect of mineral and polymer fibers on the physico-mechanical characteristics of GFB.

2. Materials and methods of research

The experimental part was carried out using basaltic, polymeric and chrysotile-asbestos fibers. High-strength gypsum of G-16 grade was used as a binder [19]. The known characteristics of the used fibers are presented in Table 1.

Table 1. Characteristics of fibers for GFB.

	Length of fiber, mm	Diameter of fiber, micron	Recommended dosage
Mineral basalt fiber	15	60	up to 1% of the mass of the raw meal
Polymer fiber	12	50	from 0,6 kg to 1,5 kg per 1 m ³ of raw mix
Asbestos fiber	1...3	20...80	Unknown
Fiberglass	10-12	unknown	Unknown

Taking into account the properties of the materials used, the compositions were calculated. The GFB samples obtained from these compositions were dried at 60 °C after strength of gypsum were set. The evaluation of the characteristics of the samples was carried out according to the technical regulations [20]. For all formulations, the flexural strength and density were determined. Visually assessed the appearance. For GFB with asbestos and glass fiber also determined thermal conductivity and water absorption.

3. The research part

Because of the conducted experiments, it was found that with the accepted method of preparing a mixture of raw components (preliminary dry mixing) and further pressing it, basalt and polymer fibers cannot be evenly distributed over the volume of the mixture.

The introduction of these fibers with mixing water is not possible, because the raw material mixture is moistened during the pressing process by spraying a clearly defined amount of water. The glass fiber, when mixed via dry methods were curled, which reduces the efficiency of its operation as a fiber.

Preliminary results showed that basaltic and polymeric fibers practically do not change the properties of GFB (figure 1). This is probably due to the impossibility of their uniform distribution over the volume of the boards with the accepted manufacturing method. With an excessive content of these fibers, there is a slight decrease in the flexural strength and deterioration in the appearance of the cut of the board after sawing due to the presence of large inclusions of fiber bundles. In this regard, the use of basaltic and polypropylene fiber seems inexpedient.

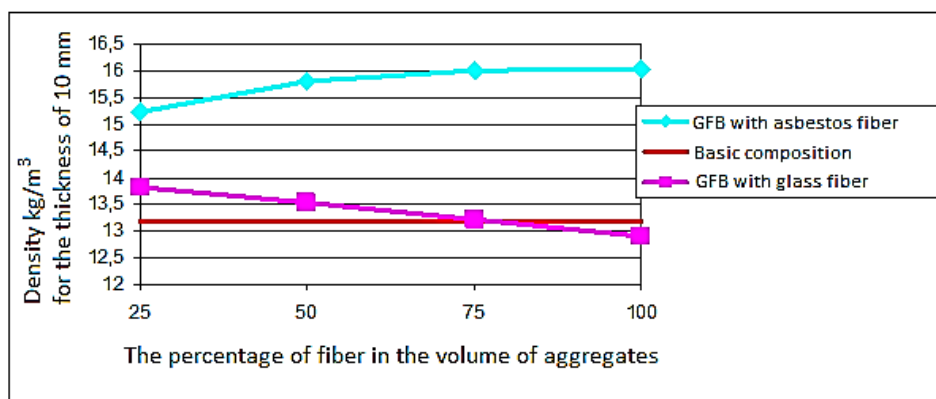


Figure 1. Dependence of density on the amount of fiber.

The density of GFB naturally increases with the increase of the amount of asbestos fiber. The greater density of this fiber in comparison with paper fiber explains it. Therefore, it decreases with increasing the dosage of glass fiber.

The flexural strength of the boards with asbestos fibers is significantly increased (figure 2). The maximum strength being achieved at a ratio of "paper fiber / asbestos fiber" equal to 1: 1 by volume. When glass fiber is used, the strength of GFB samples is practically unchanged compared to boards with paper fibers.

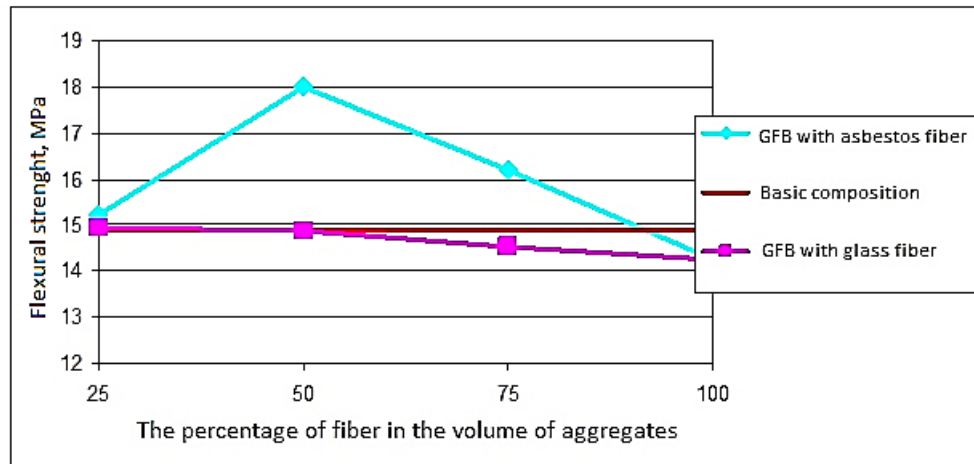


Figure 2. Dependence of the flexural strength on the amount of fiber.

Dependence of water absorption on the amount of fiber is shown on figure 3. Reduction of water absorption with increasing amount of asbestos and fiberglass is associated with the structure of the fibers used: asbestos fibers look like closed tubes, fiberglass has a dense vitreous structure. These fibers retain much less water than paper fiber.

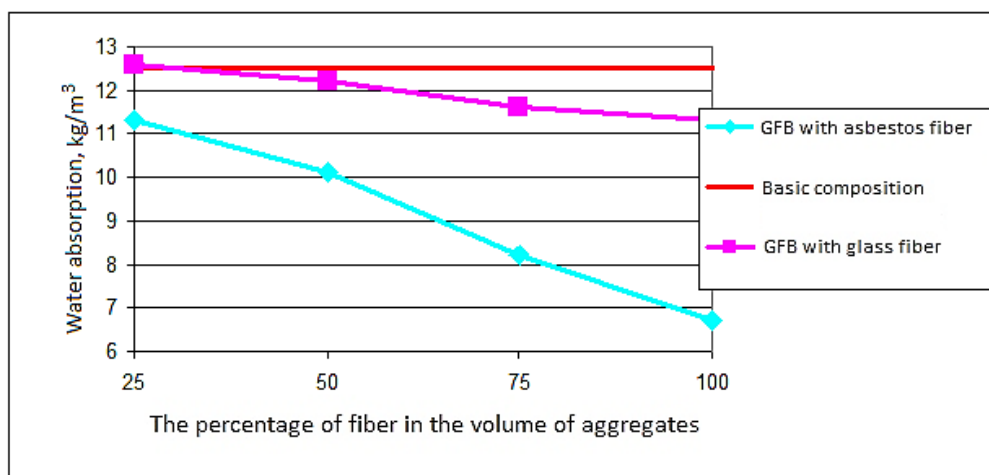


Figure 3. Dependence of water absorption on the amount of fiber

The thermal conductivity of all samples with asbestos fibers is much higher than for samples based on paper fibers, which is due to the high density of the resulting material (figure 4). When using glass fiber, the thermal conductivity is almost unchanged compared to paper fiber.

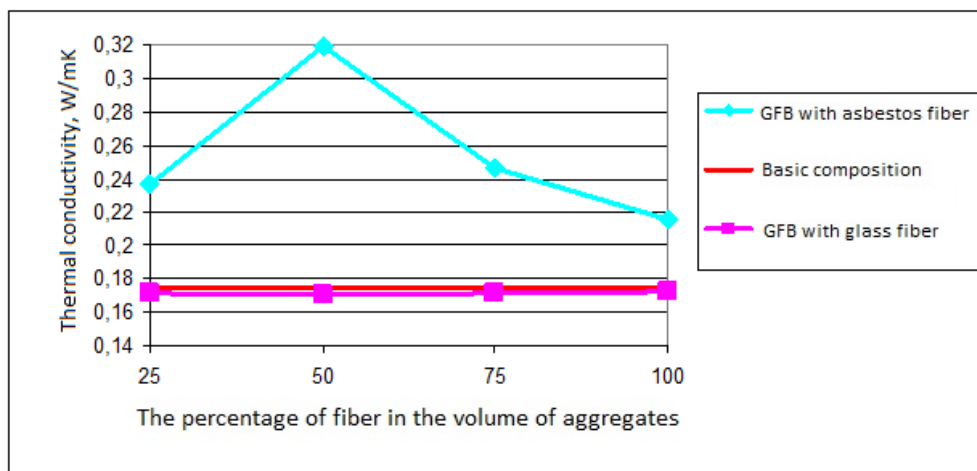


Figure 4. Dependence of the thermal conductivity on the amount of fiber.

Thus, with the chosen method of producing GFB, it is expedient to use asbestos fiber in an amount up to 100% to increase the flexural strength and reduce the water absorption. In addition, chrysotile-asbestos has a high refractoriness. It is non-flammable like fiberglass, therefore replacement of a portion of combustible paper fibers with asbestos or fiberglass should positively affect the fire resistance of gypsum-fiber boards. However, the use of fiberglass can lead to technological problems when transporting the molded boards when it moved from one conveyor to another.

4. Conclusions

With the chosen method of producing GFB, the introduction of basalt and polymer fibers practically does not affect its properties. It is due to the impossibility of forming a homogeneous structure of the composite material due to the uneven distribution of fibers in the volume of the boards.

Asbestos fiber in an amount up to 100% distributed in the volume of the board evenly can significantly increase the flexural strength of gypsum product and reduce its absorption. Replacement a part of paper fiber with asbestos or glass should also help increase the resistance of gypsum-fiber boards to fire burning. However, the use of fiberglass results in a reduction in the strength of the samples immediately after molding.

The use of asbestos fiber leads to a significant increase in the density and thermal conductivity of the resulting material.

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