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RHEOLOGICAL PROPERTIES OF POLYMER-MINERAL COMPOSITIONS

Abstract. The authors studied polymer-mineral compositions based on unsaturated polyester resins PN-1, PN-3 and various fillers - by-products of the phosphorus industry.

Keywords: composite building materials, quartzites, pirated oat, industrial waste, polymer concrete, structure, binder, fillers.

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Introduction. Modern production of competitive building materials involves the full acceleration of scientific and technological progress, the creation and introduction into construction practice of new efficient materials and intensive technologies using by-products and industrial waste, providing significant savings in raw materials, energy and labor costs while improving the quality and durability of products.

The primary task of modern building materials science is the creation of efficient and economical materials with predetermined properties and rational technologies for their production in the best way, this problem is solved in the way of obtaining composite materials based on mineral, organic, metallic and other binders.

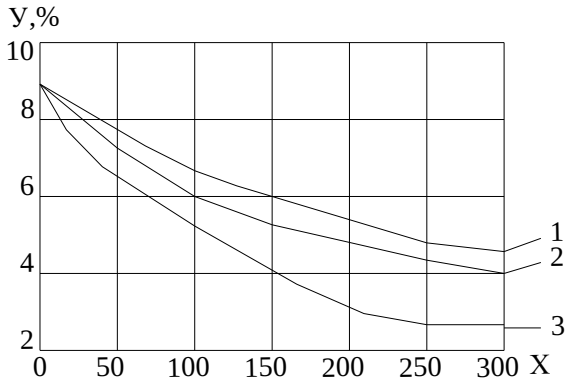
The authors studied polymer-mineral compositions based on unsaturated polyester resins PN-1, PN-3 (produced in the Russian Federation) and various fillers - by-products of the phosphorus industry.

Conditions and methods of research. The curing of polymer compositions in most cases occurs in the following stages [1-3]. During polymerization, a small number of crosslinks are initially formed. at this stage, the composition is still sufficiently elastic, relaxation processes easily proceed in it, and there are practically no internal stresses. As crosslinking continues, the number of crosslinks increases, the rigidity of the composition increases, and finally, there comes a point when a product with a very three-dimensional structure is formed. By this time, shrinkage deformations and temporary internal stresses reach their maximum values.

At the same time, it should be noted that the absolute value of shrinkage is not a criterion for internal stresses. With greater shrinkage and a small modulus of elasticity, internal stresses will be insignificant.

Low shrinkage in materials with a high modulus of elasticity causes significant internal stresses.

Research results. For filled polymer compositions, this picture is even more complicated. An increase in the degree of filling the system with quartzite, phosphorus slag, pyrite cinder and many other fillers leads to a significant decrease in the shrinkage of the polymer composition (Fig. 1).



1 – quartzite fines; 2 – pyrite cinder; 3 – dense phosphorus slag.

Fig. 1. Dependence of volumetric shrinkage (y) on the degree of filling (x) and the type of filler

If we assume that shrinkage stresses depend only on shrinkage deformations, then the introduction of mineral fillers should lead to a sharp decrease in shrinkage stresses.

However, this assumption does not take into account the corresponding increase in the elastic modulus and more adhesive bonds due to the formation of ordered supramolecular structures.

With an increase in the degree of filling, the elastic modulus increases faster than shrinkage narrows (Table 1).

Table 1

Influence of the degree of filling with quartzite filler on shrinkage, modulus of elasticity and internal stress of the composition

Binders	Degree of filling, %	Comp-ressive strength, MPa	Volume shrinkage, %	Shrinkage reduction, %	Modulus of elasticity, MPa 10	Increase in modulus of elasticity, %	Internal stresses, MPa
PN-1	0	125	9	100	100	2.4	-
	50	116	7.75	116	137.5	3.3	-
	100	137	7	128.5	221	5.3	-
	200	138.5	5.3	170	337.5	8.1	-
	300	134	4.5	200	437.5	10.5	-
	400	131	4	222	480	11.5	-
	600	76	-	-	304	7.3	-

Thus, for filled systems containing 300% by weight of the filler, shrinkage compared to an unfilled system decreased by about 2 times, and the elastic modulus increased by 4-5 times [4-5].

The limiting critical values of shrinkage internal stresses, depending on the type and amount of mineral fillers, are given in Table 2.

Table 2

Influence of various fillers and limiting critical internal stresses, MPa

Filler	Filler content, %			
	0	50	100	200
	Resin PN-1			
Quartz fines	2.5-2.7	3.5	4.8	9
Pyrite cinder	2.5-2.7	3.2	4.5	9.6
Phosphorus slag	2.5-2.7	3.1	1	-

Discussion of the results. The introduction of mineral fillers into the thermosetting resin (PN-1), regardless of their type, significantly reduces the shrinkage of the polymer composition. At the same time, such fillers as fine quartzite and pyrite cinder are highly active and are able to specifically interact with the binder, accelerating polymerization processes and causing a significant increase in shrinkage stresses.

Phosphorus slag, as a less active filler, slows down the polymerization process, reduces shrinkage stresses in the system while reducing adhesion (Table 3)

Table 3

Phosphorus slag and adhesion

Content			
Phosphorus slag, %	0	50	100
Adhesion, MPa	14-16	10.5-12	8-9

Thus, the maximum value of adhesive bonds and cohesive strength of the polymer are determined by the minimum value of shrinkage stresses.

Therefore, one of the ways to obtain high-strength, reliable, and durable polymer compositions is to find possible ways to reduce temporary and residual shrinkage stresses.

Conclusion. The results of research and experimental semi-production verification showed that, with optimal compositions and the correct technological regime for obtaining polymer compositions, they can be successfully used as thin-layer wear-resistant coatings for reclamation and hydraulic structures.

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ПОЛИМЕРМИНЕРАЛДЫҚ ҚҰРАМДАРДЫҢ РЕОЛОГИЯЛЫҚ ҚАСИЕТТЕРІ

Аңдатпа. Жұмыста PN-1, PN-3 қанықпаған полиэфирлі шайырлар және әртүрлі толтырғыштар – фосфор өнеркәсібінің қосалқы өнімдері негізіндегі полимерлі-минералды композицияларды зерттеу қарастырылған.

Тірек сөздер: композициялық құрылыс материалдары, кварциттер, техногендік қалдықтар, полимербетон, құрылымы, байланыстырғыштар, толтырғыштар.

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РЕОЛОГИЧЕСКИЕ СВОЙСТВА ПОЛИМЕРМИНЕРАЛЬНЫХ КОМПОЗИЦИЙ

Аннотация. В работе рассмотрены исследования полимерминеральные композиции на основе ненасыщенных полиэфирных смол ПН-1, ПН-3 и различные наполнители – сопутствующие продукты фосфорной промышленности.

Ключевые слова: композиционные строительные материалы, кварциты, техногенные отходы, полимербетоны, структура, связующее, наполнители.