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ЭФФЕКТИВНЫЕ КОМПОЗИЦИОННЫЕ МАТЕРИАЛЫ НА ОСНОВЕ МИНЕРАЛЬНЫХ ВЯЖУЩИХ

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Аннотация. *Появление в 1980-х годах эффективных химических модификаторов, регулирующих свойства бетонных смесей, позволило значительно улучшить физико-механические свойства получаемых бетонных композитов. Применение таких составов способствовало развитию технологии бетонирования особо сложных конструкций, позволяющей не только повышать прочностные показатели бетонов до 100-120 МПа, но и применять обычные и высокопрочные бетоны.*

Структура и свойства многокомпонентных связующих определяются выбором необходимых исходных материалов, а также их соотношением, дисперсией и активностью. Таким образом, необходимым условием создания ВВ является обязательное наличие в его составе органического модификатора, выступающего в роли усилителя дробления. Целью совместного дробления клинкера, органического компонента, вводимого в определенном количестве, и минеральных добавок в виде отходов производства (отходы горно-обогатительных комбинатов (ГОК), разрушения при дроблении агрегатов из твердых пород, активных минеральных добавок природного и искусственного происхождения) является не только получение определенной дисперсии сортировщика, но и установление физико-химических связей между активной поверхностью частиц клинкера и органической добавкой.обеспечение взаимодействия до полного соединения.

В данной работе рассматривается модификация вторичных термопластичных полимеров, в частности, вторичных полиамида и силикатглибы цементными вяжущими составами, при использовании которых возможно получение материалов с высокими физико-механическими свойствами, улучшенными гидрофизическими и трибологическими показателями. Снижение затрат на строительство можно решить за счет приобретения новых строительных материалов. Минеральные вяжущие, несмотря на свои преимущества, имеют ряд недостатков и требуют введения модифицирующих добавок.

Модифицирующие компоненты позволяют сократить сроки выполнения работ и увеличить оборот оборудования и оснастки за счет улучшения физико-механических, гидрофизических и технологических характеристик строительных материалов.

Ключевые слова: *полимер-цемент, поливинилхлорид, полиамид, модификация, прочность на сжатие, средняя плотность, водопоглощение.*

МИНЕРАЛДЫК БАЙЛООЧУ НЕГИЗДЕЛГЕН ЭФФЕКТИВДҮҮ КОМПОЗИЦИЯЛЫК МАТЕРИАЛДАР

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Аннотация. *1980-жылдары бетон аралашмаларынын касиеттерин жөнгө салуучу натыйжалуу химиялык модификаторлордун пайда болушу, алынган бетон композиттеринин физикалык-механикалык касиеттерин кыйла жакшыртууга мүмкүндүк берди. Мындай кошулмаларды колдонуу бетондордун бекемдик көрсөткүчтөрүн 100-120 МПа чейин гана жогорулатпастан, кадимки жана жогорку бышык бетондорду колдонууга мүмкүндүк берген өзгөчө татаал конструкцияларды бетондоо технологиясын өнүктүрүүгө өбөлгө түздү.*

Көп компоненттүү бириктиргичтердин түзүлүшү жана касиеттери керектүү баштапкы материалдарды тандоо, ошондой эле алардын катышы, дисперсиясы жана активдүүлүгү менен аныкталат. Ошентип, ВВНЫ түзүүнүн зарыл шарты анын курамында майдалоону интенсификатордун ролун аткарган органикалык модификатордун милдеттүү болушу болуп саналат. Клинкерди, белгилүү санда киргизилүүчү органикалык компонентти жана өндүрүш калдыктары түрүндөгү минералдык кошулмаларды (тоо-кен байытуу комбинаттарынын калдыктары (ГОК), катуу тоо тектеринен агрегаттарды майдалоону жок кылуулар, табигый жана жасалма келип чыгуудагы Активдүү минералдык кошулмалар) биргелешип майдалоонун максаты-бул иргөөчү белгиленген дисперсияны алуу гана эмес, ошондой эле клинкер бөлүкчөлөрүнүн Активдүү бети менен органикалык кошумчанын ортосундагы физикалык-химиялык өз ара аракеттенүүнү толук байланыштырууга чейин камсыз кылуу.

Бул эмгекте экинчи термопластикалык полимерлердин, атап айтканда экинчилик полиамид жана силикат-глибанын цементтик бириктиргич кошулмалары менен модификациясы каралат, аларды пайдаланууда жогорку физикалык-механикалык касиеттери бар, гидрофизиялык жана трибологиялык көрсөткүчтөрү жакшыртылган материалдарды алуу мүмкүн. Курулуш чыгымдарын азайтуу жаңы курулуш материалдарын алуу менен чечилиши мүмкүн. Минералдык астргененттер, артыкчылыктарына карабастан, бир катар кемчиликтерге ээ жана модификациялоочу кошулмаларды киргизүүнү талап кылат.

Модификациялоочу компоненттер курулуш материалдарынын физикомеханикалык, гидрофизикалык жана технологиялык мүнөздөмөлөрүн жакшыртуунун эсебинен жумуштарды аткаруу мөөнөтүн кыскартууга жана жабдуулардын жана жабдыктардын жүгүртүлүшүн көбөйтүүгө мүмкүндүк берет.

Өзөктүү сөздөр: *полимер-цемент, поливинилхлорид, полиамид, модификация, кысуу күчү, орточо тыгыздыгы, сууну сиңирүү.*

EFFECTIVE COMPOSITE MATERIALS BASED ON MINERAL BINDERS

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Abstract. *The appearance in the 1980s of effective chemical modifiers regulating the properties of concrete mixtures made it possible to significantly improve the physical and mechanical properties of the resulting concrete composites. The use of such compositions contributed to the development of concreting technology of particularly complex structures, which allows not only to increase the strength indicators of concrete up to 100-120 MPa, but also to use conventional and high-strength concrete.*

The structure and properties of multicomponent binders are determined by the choice of the necessary starting materials, as well as their ratio, dispersion and activity. Thus, a necessary condition for the creation of explosives is the mandatory presence of an organic modifier in its composition, acting as a crushing amplifier. The purpose of joint crushing of clinker, an organic component introduced in a certain amount, and mineral additives in the form of production waste (waste from mining and processing plants (GOK), destruction during crushing of aggregates from *hard rocks, active mineral additives of natural and artificial origin) is not only to obtain a certain sorter dispersion, but also to establish physio – chemical connections between the active surface of clinker particles and the organic additive ensuring interaction until full connection.*

In this paper, we consider the modification of secondary thermoplastic polymers, in particular, secondary polyamide and silicate slabs with cement binders, using which it is possible to obtain materials with high physical and mechanical properties, improved hydrophysical and tribological parameters. The reduction of construction costs can be solved by purchasing new building materials. Mineral binders, despite their advantages, have a number of disadvantages and require the introduction of modifying additives.

Modifying components make it possible to reduce the time of work and increase the turnover of equipment and tooling by improving the physical, mechanical, hydro physical and technological characteristics of building materials.

***Keywords**: polymer-cement, polyvinyl chloride, polyamide, modification, compressive strength, average density, water absorption.*

Introduction. Both components are usually involved in the hardening of binders with polymer additives. The degree of such participation largely depends on the properties and composition of both the inorganic binder and the polymer additive. Such compositions acquire properties from each component, while polymer additives increase the ultimate extensibility of concrete, their impact strength, tensile and bending strength, abrasion resistance, adhesion to other materials, etc.[1]

The increased cost and specific properties of polymer-cement materials determine the rational areas of their application: thin-layer coatings, adhesive compositions during finishing and repair work, homologating compositions, etc.[2].

Polyvinyl chloride (PVC) is one of the multi-tonnage polymers and, accordingly, forms the largest amount of waste, since it is used in various fields of technology for the production of both construction and other industrial and household materials and products (linoleum, siding, finishing plates, pipes, casings, baseboards, furniture, containers, packaging, etc.) The share of technogenic PVC waste accounts for 60% of the total amount of all polymer waste. Recycling of PVC waste is difficult due to the fact that PVC materials and products have a complex composition, including various additives, and undergo significant changes during operation [3]

A significant place among solid polymer waste is occupied by polyamide waste (PA), formed mainly during the production and processing into fiber products (nylon and amide), as well as disused products. The amount of waste in the production and processing of fiber reaches 15% (11...13% of them in production). Since PA is an expensive material with a number of valuable chemical and physico-mechanical properties, the rational use of its waste is of particular importance [4].

Waste recycling contributes to the improvement of the environmental situation and the introduction of waste-free technologies for the production of materials and products [5]. It should be noted that polymer additives are usually introduced into building materials in small quantities (1 – 5% by weight of the mineral binder) in order to plasticize or hydrophobize them [6].

The relevance of the topic and the formulation of tasks. The aim of the work is to develop composite materials based on mineral binders modified with dispersed additives of secondary thermoplastic polymers, with the use of which it is possible to obtain materials with high physical and mechanical properties and improved hydrophysical parameters. Current environmental problems, as well as the depletion of the raw material base of our country have shown the relevance of research for modern materials science.

Theoretical justification. In this work, the composition of the resulting cement-polymer material included the following components: portland cement 500-D20 (GOST 10178 – 85) with a normal density of cement dough of 25% was used as a mineral binder, secondary polyamide (TU 6 –13–3 –88) and secondary polyvinyl chloride (GOST 14332 – 78), cryogenically crushed to 0.14-0.63 mm.

The cement-polymer material was obtained by mixing a fine polymer with cement to a homogeneous state and then gradually adding mixing water with the addition of hyperplasticizer Relamix (TU 5870 – 002 – 14153664 – 04) injected in an amount of 0.45%.

The polymer was injected in an amount of 2.5; 5% and 15% by weight of the mineral binder (P / C = 0.026; 0.056; 0.176). The finished modified mixture was placed in molds in the form of beams with a size of 40x40x160 and compacted on a vibrating platform for ≈ 1min. Next, the samples were placed in a steaming chamber for 12 hours with a temperature of 80-850C. After 7 days, the bending strength of the obtained samples was tested. For the determination, a Quasar 50 press was used, during the tests, the load was gradually increased until the samples were destroyed. After 28 days, the compressive strength was determined, during the tests, the load was also gradually increased until the samples were destroyed.

To determine the water absorption of the samples, they were weighed on a scale. Then the samples were placed in a container filled with water so that the water level in the container was above the upper level of the stacked samples by about 50 mm, the water temperature in the container was (20 ± 2) ^{0}C. 24 hours after the samples were immersed in water, they were taken out of the water, wiped with a cloth, weighed on a scale; on the basis of which the water absorption of the obtained materials was determined.

The abrasion of cement-polyamide samples was determined at the age of 7 days (GOST 13087 – 81). The samples for testing on the abrasion circle had the shape of a cube with an edge

70 mm long. The samples were tested in series. The number of samples in the series is three, they were installed in special sockets of the abrasion circle. A concentrated vertical force of 300 N was applied to each sample (in the center), which corresponds to a pressure of 60 kPa. The first portion of 20 g of grinding grain 160 – 200 microns (GOST 3647 – 80) was

poured on the abrasion disc in a uniform layer. After installing the sample and applying the abrasive to the abrasive disc, the wheel drive was turned on and abrasion was performed. Every 30 m of the abrasion path traversed by the samples (28 revolutions on an attrition circle of the LKI-2 type), the attrition disk was stopped. The remnants of abrasive material and powdered concrete were removed from it and a new portion of abrasive was poured on it and the drive of the abrasive wheel was turned on again.

Practical research and conclusions. The experiments have shown that the optimal composition of the mix binder is: P /C = 0.056, which is 5% polyamide and P /C = 0.026, which is 2.5% polyvinyl chloride. It is with this ratio that there is an increase in the bending strength of polyamide-cement material by 47.7%, and polyvinyl chloride-cement by 40% (Figure 1). It should be noted that with the content of 2.5% polyamide in the resulting material, an increase in compressive strength by 2.4% is observed (Figure 2).

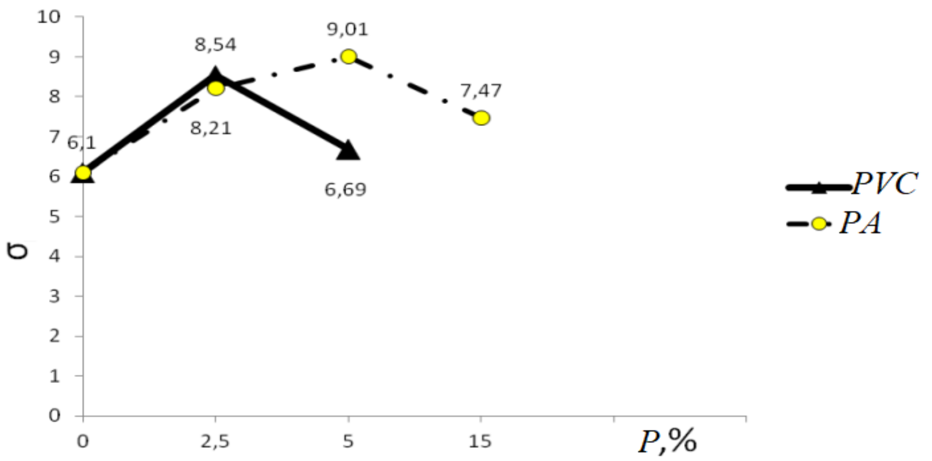

Figure 1 - Dependence of the bending strength of cement polyamide samples on the polymer content

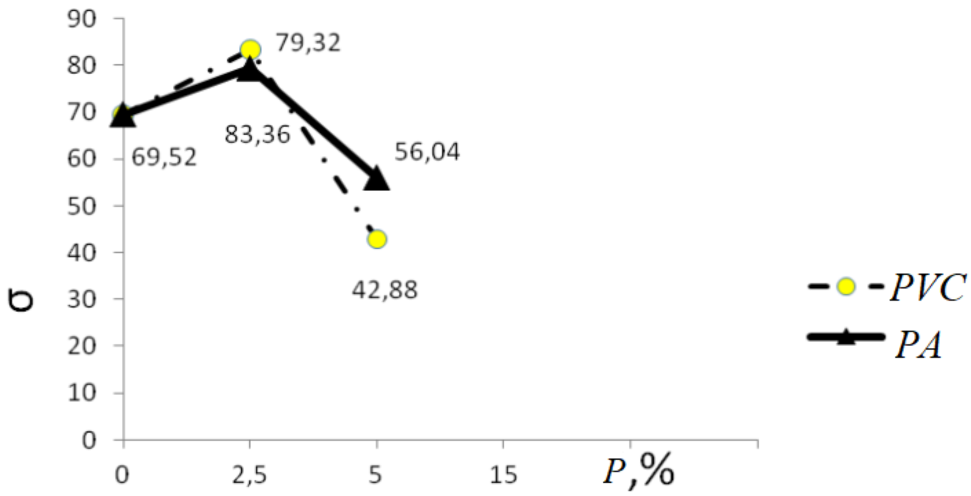

Figure 2 – Dependence of the compressive strength of cement – polyamide samples on the polymer content

This can be explained by the fact that the polymer binder forms elastic interlayers between the crystalline neoplasms of the cement binder, adsorbing on its surface and, due to the high adhesive properties of the organic binder, increases the strength and deformability of the material during bending. With a further increase in the content of the polymer component (more than 5% PA and 2.5% PVC), a decrease in the bending strength of the obtained samples is observed, which is explained by the weakening of the internal structure of the mineral matrix of cement-polymer samples. The obtained results are also confirmed by decreasing values of average density (Figure 3). This can also be explained by the fact that the true density of polymers is 2 – 3 times less than cement: the true density of polyamide is 1010 – 1140 kg/m^3, polyvinyl chloride is 1350 – 1430 kg/m^3, and cement is 3000 – 3200 kg/m^3.

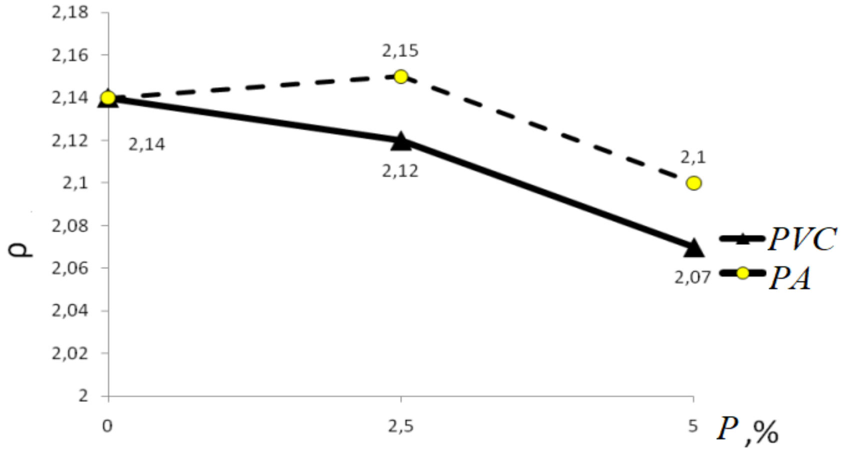

Figure 3 - Dependence of the average density of cement-polymer samples on the polymer content

When the content of polymer in cement-polyamide material is more than 2.5%, their water absorption increases by an average of 18% due to the fact that part of the water is adsorbed on particles of organic hydrophilic polyamide binder. With respect to PVC cement samples, with an increase in the polymer content to 5%, there is a decrease in water absorption by 57.5%, which can be explained by the hydrophobicity of this polymer (Figure 4).

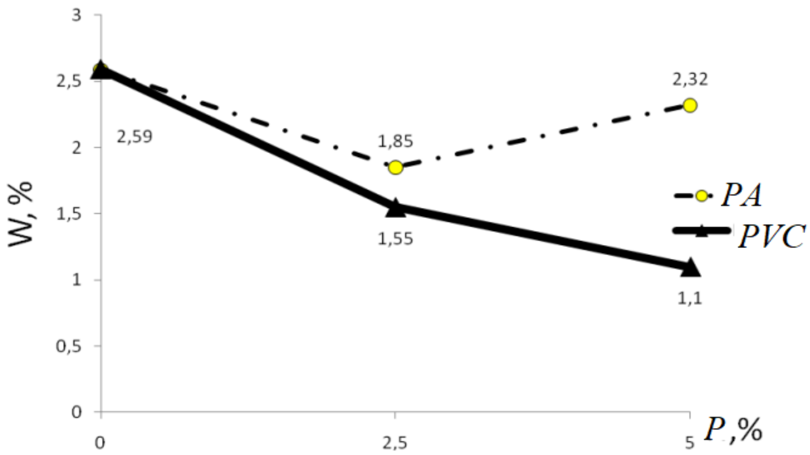

Figure 4 - Dependence of water absorption of cement-polymer samples on polymer content

A feature of cement-polyamide materials is their high wear resistance. The abrasion resistance increases with an increase in the content of polymer additives in them. A material with a secondary polyamide content in the amount of 5% (in terms of dry matter) of the cement mass in terms of wear resistance is 0.18 g / cm2, which indicates a sufficiently high wear capacity of the developed material and, consequently, the possibility of its use in road construction.

Conclusion. Thus, when comparing composite materials modified with secondary PA and PVC, it was concluded that it is possible to obtain new import-substituting materials with increased bending strength by 40 – 50%; improved hydrophysical properties and tribological characteristics. Therefore, the optimal field of application of cement-polyamide materials is: for structures working on bending; for thin-layer and road surfaces and antifriction materials, and PVC-cement materials, in addition to these areas of application, can be used to obtain adhesive and waterproofing compounds during finishing and repair work.

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