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OPTIMIZATION OF THE COMPOSITION AND PRODUCTION TECHNOLOGY OF CERAMIC ROAD SURFACES BASED ON CLAY RAW MATERIALS

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Abstract. The construction of ceramic road surfaces in residential complexes , private residential buildings and other socially significant facilities will lead to environmental and economic efficiency. For a comfortable life of residents, a special role is played by solving the problems of their improvement. In addition, one of the most important tasks is the improvement of sidewalks, courtyards and playgrounds, as well as the territories of squares, alleys and parks, which require a large amount of road-building materials. Currently, concrete pavers of various configurations and asphalt concrete are used to solve these problems. However, as practice shows, during the operation of these paths, their destruction is often observed.

An important technological stage in the production of ceramic materials is the preliminary preparation of raw materials, which requires significant energy and resources. As a result of research by scientists of modern technology for the production of ceramic tiles using the dry and wet method, it was found that in the process of preparing raw materials, a lot of energy and water is spent, and therefore is expensive both from an economic and environmental point of view. Scientists have proposed alternative methods for preparing raw materials, which significantly reduce energy and water.

Keywords: Clay, ceramic road surfaces, Shagan clay, physico-mechanical properties, local raw materials.

Introduction

The production of ceramic materials uses the highest accepted medium-melting clay , loam and yellowish soils [1,2], siltstones , algerites and fast-melting shales.

The use of these raw materials and products and the technology of their production allow us to create ceramic materials. Many effective ways to prepare products and mold them have been able to influence their properties.

These studies and experiments were made by mixing vogran slag as an auxiliary additive with clay in ceramic materials [3,4]. As a result of the study,the unsuitability in the production of products decreased by 50% in drying works, as a result of which it was possible to obtain products of the brand of ceramic bricks from 75 to 120 brands. And in the process of 10000c burning, Quartz in the heated body decreases and vollastonites increase.

The high heat retention and inability of clay to withstand shrinkage is very high compared to other ceramics, as silica or mullite compounds of minerals are found in it. But when using clay in the production of refractory ceramic bricks, it pursued the goal of reducing its high thermal conductivity [4].

Kazakhstan researcher-scientist Saibulatova S. zh. the author, referring to her research, noted that dynamic sedimentation consists of two periods: determining the smoking period and corresponding to the amount of water given in the composition, and simple periodic sedimentation, which depends on the release of water vapor in the gaseous state [5].

The research involved making ceramic bricks using three different soils. The main structure of the soil is composed (by 80% mass fraction) of mineral. Its mineralogical composition consists mainly of clay minerals, quartz and carbonates, as well as other very small minerals. In this project, raw materials were studied and collected as a basis, and then dried in a drying oven at 105\degc, and then, as usual, laboratory work began. The products are placed in a hermetically sealed container for 24 hours,protected from air flow, in a state of rest, hemogenization of moisture content of the product, that is, uniformity. After the product is crushed and shaped, continuous dewatering works are carried out and dried in a laboratory dryer oven at 105\degc, after drying in an electric oven with an average heating of 1.4 C/min to 610\degc, then continuous long-term annealing to the temperature of the last task by increasing 2.5\degc per minute to 900\degc, 950\degc and 1000\degc [6].

Ceramic products are the most durable, environmentally friendly materials that provide extended comfort, creating a climate of comfortable temperature and humidity for the environment. However, a serious problem in the production of these products is the use of low - grade raw materials with high sensitivity to drying by conducting research and experiments in production. In this regard, there is a need to develop multicomponent compositions and technologies for ceramic products using regional mineral raw materials and industrial waste.

For the production of construction ceramics, low-melting clays, loams and clays, clay, siltstones and low-melting shales are widely used.

The use of these types of raw materials in the production of Wall ceramics made it possible to create multicomponent compositions of ceramic masses, in particular, due to the introduction of additives regulating the properties of forming sands and the properties of the finished product, as well as a change in the technology of preparing raw materials [7,8,9].

It is important to note that in the process of overcoming barriers, it is influenced by many factors related to the cited research, which makes it extremely important for scientists to review the research data.

The practical and theoretical principles of creating the structure of construction ceramics at the stage of shaping, drying and firing are thoroughly studied and are based on the results of ceramic masses, the basis of which is clay raw materials. However, in the development of effective technologies for making ceramic products, non-traditional natural raw materials and, in addition, production waste with special properties are increasingly used [10]. Therefore, it is necessary to conduct additional research, taking into account the properties and specific features of the raw materials under consideration.

When creating resource-saving and energy-saving technologies of ceramic products, the use of multicomponent raw materials began to be paid more and more, which increased interest in terms of obtaining products with the necessary properties. However, for the selection of rational methods at the stage of preparation of raw materials used in the practical implementation of research results, an integrated scientific approach is required.

When choosing the method of forming ceramic masses for the production of ceramics in construction, the semi-dry pressing method has received its due recognition in recent years, which opens up wide opportunities for the use of non-plastic raw materials, including industrial waste , full automation of technological processes, integration of drying and firing processes, obtaining products with clear surfaces and accurate geometric dimensions.

Methodology

In some properties and granulometric composition, The Rock approaches closed loams. As a rule, the holes do not contain sand particles larger than 0.25 mm in size, however, this rock

contains most of the large dust (0.05-0.01 mm). Its content usually reaches 60-70%. The Rock is distinguished by weak layering, micro-aggregation, high water permeability. Loess-carbonate rocks. In dry areas, they can be salted and contain gypsum particles.

Ceramic materials used for production in the production of products must comply with the current regulatory and technical documents for the production of these materials, as well as technical documentation and obtain from the characteristics of the products being removed from this. My problem is to improve the properties of Chagan loam by adding additives to its properties. Therefore, the study of its basic mineral composition is an important case.

Raw materials containing the mineral Al_2O_3 belong to the acidic raw material type. And he, in turn, is considered to have a low firing temperature. And raw materials containing Fe_2O_3 are considered to be of high quality (Table 1).

Table 1 . Share of chemical minerals of Shagan loam of West Kazakhstan region

Raw material name	Oxygen contacts, drunk.%												
	SiO_2	Al_2O_3	TiO_2	CaO	MgO	Fe_2O_3	P_2O_5	F	SO_3	CO_2	Na_2O	K_2O	п.п.п.
Shagan on clay	51,27	12,13	-	11,97	2,09	4,88	-	-	2,43	-	3,56	-	11,67

In the course of differential and thermal analysis, 120 °C loses its external water due to internal conditions. At 280°C, organic minerals burn out.

To create a ceramic composition for the system Loess –like loam-Chagan field in clay, bentonite clay was pre - dried at a temperature of 90-100 °C to a constant weight. The dried clay was ground to a certain surface area of 1000-1200 cm2 / G in a laboratory ball mill. Grinding was also carried out on glass powder.

The course of research was made by saturating clay - bentonite powder with water.

To create a ceramic composition for the system, use Loess-like loam and

made from bentonite powder clay and glass crusher. Clay and bentonite powders were then dried and crushed and prepared. We mix the dry mixture, that is, glass powder for loam and bentonite clay in a ratio of 80-85:5-10:5-10 in a ball mill and saturate the mixed mixture with water. The resulting ceramic mass is brought to a moisture content of 20-30%.

Cylinder samples (5x5x5 CM) were formed by semi-dry vibropressing from the studied mineral compositions of raw materials mixtures. Pressing pressure 10 MPA. After that, AZA-sensitive drying of the molded product was carried out, and annealing was carried out in furnaces with an exposure of 8-10 hours at the appropriate temperature. The temperature speed was carried out at a speed of 100 degrees per hour.

For the research work, the characteristics of the most important operational features of the emerging ceramics that occur during heat treatment were selected, such as fire shrinkage, general strength during compression and bending, general average density, material water absorption. Table 2 shows the physical and mechanical properties of heat-treated material or ceramic samples at different temperatures.

Table 2. Physical and mechanical properties of ceramic samples loam-bentonite-glass powder

Burn temperature, ^0C	Burner shrinkage, %	Average density, г/см^3	Strength, MPa		Water absorption, %
			to pressure	to bend	
900	0,05-0,01	1740	9,4-10,1	1,62-1,8	18,42

1000	0,10-0,12	1784	11,0-11,5	2,1-2,4	16,43
1100	0,13-0,16	1790	11,6-12,05	2,3-2,5	15,24

Thermal processing of samples was carried out according to the effective optimal composition of raw material compositions-85% bentonite clay, bentonite powder with an admixture of 10% bentonite and 5% glass powder were used.

The introduction of bentonite in powder form leads to the formation of stress in the process of drying raw materials due to the difference in water consumption and moisture supply, as well as the swelling of loam and bentonite. The difference in the linear dimensions of the samples is 35%.

The raw mixture is then molded by semi-dry vibropressing. The pressing pressure is 10-15 MPA. Due to the high sensitivity to drying, cast products were dried in conditions of complete drying, protected from gusts of air, wind. The dried product was fired in a muffle oven from 100 ° C to 1100 ° C. The rate of temperature rise is 1.5-2 ° C per minute.

Preparation of samples in the form of cubes with a wall size of 5x5x5 CM was carried out by pressing the mixture from raw materials. The moisture content of the mass was 20% of the mass of dry components, the pressure was 10 - 15 MPA.

The maximum firing temperature was up to 1000 degrees Celsius with a rise rate of 2.5 degrees per minute.

Testing work was carried out on 3 ceramic components of the cylinder-shaped product in question. The main requirement is to increase the binding capacity of Chagan loam, and to some extent to increase its physical and mechanical properties. In these samples, small explosions occurred, although the degrees of explosion were not clearly known in each mixture. In order to avoid these obstacles, I studied its differences during the main drying process.

The first thing I did was mold Shagan clay without additives (Figure 1). I compared the results obtained from it with products with added additives.



Figure 1 – Ceramic samples in drying condition

With regard to changes in the average density and water absorption in the systems under consideration, there is a decrease in water absorption and an increase in the average density in both ceramic compositions (Figure 2). However, in the clay-bentonite powder system, water absorption decreases from 21.7% to 19.6%. The loam system contains 15% to 20% bentonite and glass powder. In the clay-bentonite powder system, the average density increases from 1.65 to 1.83 g / cm3. When used in the form of glass powder from 1.75 to 1.9 g / cm3, it is administered in the form of glass powder. The data obtained clearly show that all the studied properties were significantly improved with the introduction of bentonite–glass in the form of water saturation.



Figure 2 – view of road surfaces that have undergone annealing

When applying ceramic compositions in the range of 900-1000°c, there is a significant increase in strength indicators, and the maximum strength in the specified temperature range was achieved by a ceramic composition with a suspension and is 9.4-12.5 MPA. This powder is 9% more than the composition with bentonite.

Results and Discussion

For the main production of ceramic products, the main sources of raw materials are required: clay, kaolin, loam, clay shale.

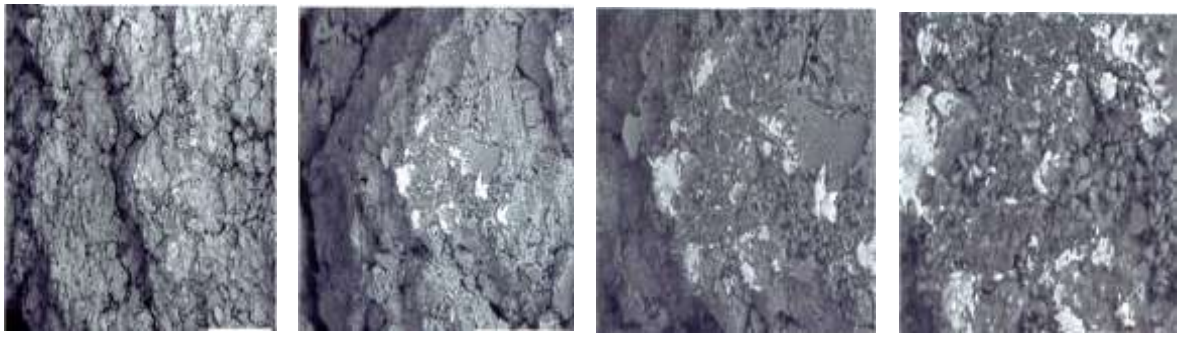
Loams are a mixture of large volumes of sand and mixed silt, as well as clay with the minerals calcium carbonate and water and bound iron oxide. The main main features of particles , i.e. minerals

by nature, loams from the level of > 0.015 mm are divided into thick and surface thin, and according to the significance of the production of clay particles, they are divided into heavy and light-weight loams. Loams are the predominant types of relative clay particles (up to 50% -33.3%), in which there is a lot of rock (Figure 3). This is the case when ceramic materials are of particular importance in determining the most important characteristics of materials for construction production water aluminosilicate is a complex compound. Their properties: bonding, ductility, calcined raw materials vary according to their mechanical strength.

Loams are characterized by minerals with very small particle sizes, no more than 18 micrometers, and have dimensions of more than 2 micrometers. The natural construction of the parts the mineral sum of the ceramic maker must be at least 1.5 microns and in the range from 10% to 40-55%.

The chemical composition of raw clay materials for the production of bricks and stones varies depending on the location, time of formation: Al2O3+TiO2 – 8-28%; CaO – 0.5-25%; SiO2 – 45-80%; Fe2O3 – 2-8%; MgO – 0-4%; R2O – 0.3 – 5%; the share of other minerals-3-6%.

Granule-shaped (granular) composition – an intermediate size ratio of particles of different sizes and fractions, expressed as a percentage by mass fraction. The granule-shaped composition is characterized by the size of loamy fractions (less than 0.004 mm), dusty particles (0.004-0.14 mm) and fine sand(0.14-5 mm). The ratio between these fractions uniquely determines such properties in materials as bonding shrinkage, ductility, and susceptibility to drying.

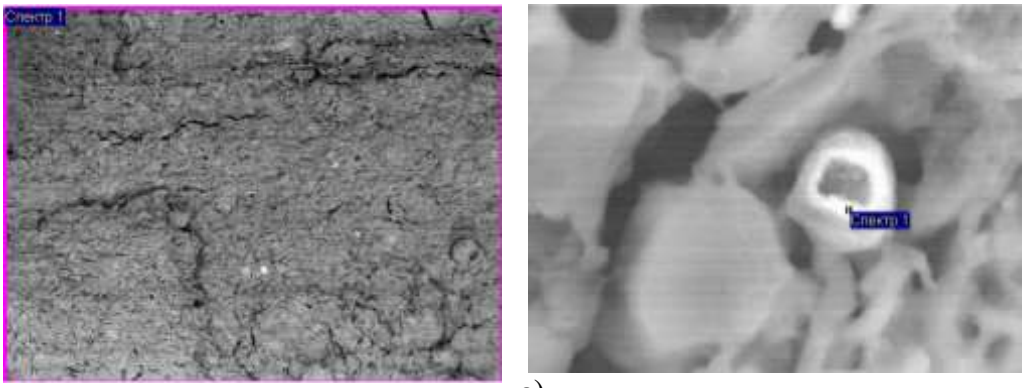


a) b) c) d)

Figure 3 – microstructure of the Shagan loam of the WKO, with different magnifications.
a-Magnification 100 times ; b-magnification 500 times;
c-magnification 1000 times; d-magnification 2000 times

An increase in the amount of clay substance gives the loam a significantly higher plasticity and resistance to rapid crushing in water, but, on the contrary, increases the overall and air shrinkage and increases the sensitivity to drying. Clay plasticity refers to the fact that clay materials, under the influence of a force acting from the outside, take on different shapes, without breaking its integrity, and do not return to their elastic place after this force is obtained. The deformation that occurs in this case is characterized by the breaking of bonds between some atoms and the formation of new ones.

A comprehensive and comparative analysis of microstructure, change and distribution, basic silicate-forming chemical elements in ceramic masses the introduction of bentonite powders with a high surface area (1200-1500 cm2/G) indicates a significant General change in the morphology of the microstructure of the ceramic composition of loams-bentonites. Confirmation of this is electronic images made at different magnifications of a ceramic composition of pure loam and modified bentonite clay (Figure 4).



a) b)

Figure 4 – microstructure of the composition of loam-bentonite-glass powder.
a) increased by 100 times; b) increased by 5000 times

Microscopic studies were carried out under the image electron microscope JSM-6490lv. INCA Energy 350 is equipped with an energy-saving micro-filter system and a device for studying the texture and micro-radiation of HKL Basic polycrystals and crystals.

Conclusion

Based on the results of the methods of studying physico-mechanical and chemical-mineralogical indicators and characteristics of the obtained raw materials, it was proposed to create an effective technology for obtaining high-quality ceramic road surfaces by semi-dry vibropression according to a number of research methods, thanks to the raw material composition, research and experiments made by adding additives of bentonite clay and glass powder to Chagan Loess loam.

It was proved that it is possible to increase the physical and mechanical properties of loess-like loams by adding additives to them by converting them.it was also proposed to mix them in powder form in a ball mill in 3 different ratios to choose a rational method of introducing the mixture into the composition of the ceramic mass.

It was found that a ceramic composition based on Loess-like loam helps to improve the formation properties due to the addition of bentonite clay as an additive. And the addition of glass to it allowed it to increase its individual physical properties.

A significant difference was found between the processes of forming the structure in comparison with pure loam and modified ceramic compositions. In the ceramic composition modified by bentonite clays, ceramic fragments of chemical elements such as Si, Al, Na, K increase due to the chemical composition of bentonite clay. This can be seen to have a positive effect on the overall stable formation of the crystalline phases of albite and anorthite as strengthening minerals in the ceramic fracture microstructure that determines the production of road surfaces. Loess-like indicates that Clay is enriched with chemical elements. The resulting ceramic product is distinguished by high strength, frost resistance and good water-absorbing properties.

The technology of roadbed ceramics based on bentonite clay and glass powder mixtures and modified Loess-like loams is developed, according to which it introduces dry-state mixing technology, which greatly simplifies the manufacturing process of high plastic ceramics and guarantees the improvement of high plasticity during molding , reducing the shrinkage indicator during drying and firing stage gives a significant relief to the production progress of the product.

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Contribution of authors:

Dosov Karzhaubai Zhanabaevich – the research concept, methodology, and organization of experimental work.

Idirisov Beksultan Lepesuly – data analysis, conducting laboratory tests, text preparation, scientific editing, collecting data.

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Use of artificial intelligence (AI): Artificial intelligence was used to check the grammar and spelling of the text of the article.

САЗДЫ ШИКІЗАТЫ НЕГІЗІНДЕ КЕРАМИКАЛЫҚ ЖОЛ ТӨСЕМДЕРІНІҢ ҚҰРАМЫН ЖӘНЕ ӨНДІРУ ТЕХНОЛОГИЯСЫН ОҢТАЙЛАНДЫРУ

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Аңдатпа. Керамикалық жол төсемерін тұрғын үй кешендерінде , жеке тұрғын үйлерде және басқа да әлеуметтік маңызы бар нысандарды салу экологиялық және экономикалық жағынан да тиімділікке әкеледі. Тұрғындардың жайлы өмір сүруі үшін оларды жақсарту мәселелерін шешу ерекше рөл атқарады. Сонымен қатар, маңызды міндеттердің бірі тротуарларды, ішкі аулалар мен ойын алаңдарын, сондай-ақ көптеген жол-құрылыс материалдарының көп мөлшерін қажет ететін алаңдар, аллеялар мен саябақтар аумақтарын абаттандыру болып табылады. Қазіргі уақытта бұл проблемаларды шешу үшін әр түрлі конфигурациядағы және асфальт бетонды бетон төсемелер қолданылады. Алайда, тәжірибе көрсеткендей, осы жолдарды пайдалану кезінде олардың бұзылуы жиі байқалады.

Керамикалық материалдар өндірісінің маңызды технологиялық кезеңі шикізатты алдын-ала дайындау болып табылады, бұл айтарлықтай энергия мен ресурстарды талап етеді. Құрғақ және дымқыл әдісті қолдана отырып, керамикалық плиткаларды өндірудің заманауи технологиясын ғалымдардың зерттеулері нәтижесінде шикізатты дайындау барысында көп энергия мен су жұмсалатындығы, демек экономикалық және экологиялық тұрғыдан да қымбат екендігі анықталды. Ғалымдар шикізатты дайындаудың баламалы әдістерін ұсынды, бұл энергия мен суды айтарлықтай төмендетеді.

Түйін сөздер: Саз, керамикалық жол төсемдері, Шаған саздағы, физика-механикалық қасиет, жергілікті шикізат.

ОПТИМИЗАЦИЯ СОСТАВА И ТЕХНОЛОГИИ ПРОИЗВОДСТВА КЕРАМИЧЕСКИХ ДОРОЖНЫХ ПОКРЫТИЙ НА ОСНОВЕ ГЛИНИСТОГО СЫРЬЯ

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Аннотация. Строительство керамического дорожного полотна в жилых комплексах, индивидуальных жилых домах и других социально значимых объектах приводит к повышению экологической и экономической эффективности. Особую роль для комфортного проживания жителей играет решение вопросов их улучшения. Кроме того, одной из важных задач является благоустройство тротуаров, внутренних дворов и детских площадок, а также территорий площадок, аллей и парков, требующих большого количества дорожно-строительных материалов. В настоящее время для решения этих проблем используются бетонные брусчатки различной конфигурации и асфальтобетонные

покрытия. Однако практика показывает, что при использовании этих путей часто наблюдается их нарушение.

Важным технологическим этапом производства керамических материалов является предварительная подготовка сырья, что требует значительных энергозатрат и ресурсов. В результате исследований ученых современной технологии производства керамической плитки с использованием сухого и влажного метода было установлено, что в процессе подготовки сырья расходуется много энергии и воды, а значит, и экономически и экологически дорого. Ученые предложили альтернативные методы подготовки сырья, что значительно снизило потребление энергии и воды.

Ключевые слова: Глина, керамическая брусчатка, Чаганская глина, физико-механические свойства, местное сырье.



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