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EXPANDING THE RAW MATERIAL BASE FOR THE PRODUCTION OF BRICK IN THE FERGANA REGION.

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Abstract:

The article is devoted to determining the characteristics of local raw materials available in the Fergana region for their suitability in the production of ceramic bricks. Investigated: loess from the «Lagan» deposit, and agricultural waste in the form of crushed cotton stalks as a burnable additive. It is shown that the studied loess is suitable for the production of bricks of a dense and porous structure in terms of the chemical and mineralogical composition of raw materials, and crushed cotton stalks can be recommended as an effective burn-out additive.

Keywords: loess, group of clay raw materials, chemical, mineralogical composition, plastic molding, burnable additives, guzapaya.

1. INTRODUCTION

The main raw material used for the production of ceramic bricks with a dense and porous structure is polymineral clay. This plastic material after firing in furnaces acquires many valuable properties. Clay, exposed to high temperatures during firing in kilns at brick factories, completely changes its properties. From a plastic mass, it becomes a solid (building) material, resistant even when exposed to permanent loads.

Fireclay, quartz sand, slag are also introduced into the raw mass. Various additives are added to clay to impart characteristic properties to ceramic products.

However, today the resource base available in the region is extremely depleted and research is required on other local clay materials as additional raw materials.

The possibility of using the loess of the "Lagan" deposit of the Fergana region for suitability in the production of ceramic bricks by the method of plastic molding was studied [1]. For this purpose, the chemical and mineralogical compositions of the studied raw materials were studied according to the main indicators provided for by GOST 9169-75 "Clay raw materials for the ceramic industry".

2. TECHNOLOGIES AND DISCUSSION OF RESULTS.

Physical-chemical and physical-mechanical tests of the loess of the Lagan deposit in the Fergana region were carried out in the laboratory of the Kuvasay brick factory.

Chemical analysis of loess for the production of fired bricks with a dense and porous structure was carried out according to GOST 21216.0-93; GOST 21216.12-93; GOST 2642.1-93. Research data are shown in Table 1.1.

CHEMICAL COMPOSITION OF RAW MATERIALS

Table 1.1

№ sample	Oxide content %								
	п.п.п	SiO_2	Al_2O_3 + TiO_2	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	Сумма
Sm.№1	12,62	50,44	14,17	5,52	9,24	2,80	2,40	2,63	0,30	100,12
Sm.№2	11,01	50,94	16,77	5,88	7,0	2,40	2,65	3,21	0,17	100,03

According to the content of Al_2O_3 in the calcined state, loess samples belong to the acidic group of clay raw materials. According to the content of coloring oxides - with a high content of coloring oxides.

Clay consists of chemical compounds of aluminum, silicon, iron, titanium, calcium, magnesium, sodium, potassium in the form of oxides, salts. Clays also contain some organic matter and water. Each of the oxides that make up the loess has its own effect on the characteristics of the loess.

Silica - silicon oxide SiO_2 - is in the loess in a bound and free state: bound silica is part of clay-forming minerals, free silica is presented in the form of quartz sand and fine dust-like particles (plough).
Quartz sand in a significant amount clogs clay and reduces its plasticity. With an increase in the amount of sand, the shrinkage of products and their mechanical strength decrease. Fine-grained fractions of sand increase the sensitivity of clays to drying. Products with a high silica content can increase in volume during the firing process due to the transformation of quartz into other modifications (varieties).
Alumina Al_2O_3 - is in the loess in a bound state, participating in the composition of clay-forming minerals and micaceous impurities. It is the most refractory oxide. With an increase in the content of alumina, the plasticity of clay increases, the strength of molded, dry and fired products increases, and their refractoriness increases.
Titanium dioxide TiO_2- is contained in a small amount (up to 15%) and gives the fired product a greenish color; the intensity depends on the ratio with other oxides.
Iron oxide Fe_2O_3 is contained mainly in the composition of loess impurities and gives them a predominantly reddish color after firing; at a content of 3% or more in a reducing environment, iron oxide significantly reduces the firing temperature of products, turning into ferrous forms. In addition to iron oxide, clays contain iron compounds in the form of pyrite, iron hydroxide, and iron carbonates.
Calcium oxide (lime) CaO and magnesium oxide (magnesia) MgO - are part of carbonate rocks - limestone, calcite, dolomite and are present in clay in the form of carbonates of calcium carbonate $CaCO_3$ and magnesium carbonate $MgCO_3$.
The calcium oxide formed during the firing process under the influence of air moisture turns into calcium oxide hydrate $Ca(OH)_2$ and, increasing in volume, destroys the products. The effect of magnesium oxide is less significant. Calcium oxide also affects the color of the resulting products and gives them a yellowish or pinkish color. Calcium oxide in a finely dispersed state makes the raw material less sensitive to drying, i.e. reduces cracking.
Oxides of alkaline materials Na_2O and K_2O are fluxes. They reduce the firing temperature and give the ceramic shard greater strength. A high percentage of them, especially K_2O, indicates a significant content of mica and hydromica in clays. These oxides are part of clay-forming minerals, but in most cases they are present in impurities in the form of soluble salts. When drying products, the latter migrate (penetrate) through the capillaries to their surface, and after firing they are sintered with a crock, forming whitish deposits on the outer surface of the product, spoiling its color.
Organic substances are always present in clays in greater or lesser quantities and give the raw material dark and gray shades, and the brick, when fired, a darker color. Organic matter plays an important role in the drying process. Being most often in a colloidal state, they bind a large amount of water, increase plasticity, and when dried, due to the removed water, they contribute to the formation of large air shrinkage, gluing and tightening the surface layers of the dried raw brick; organic matter contributes to the formation of cracks.
Volatile substances in the clay raw materials used for the production of bricks are contained in a significant amount (4-13%). Chemical analysis shows them as loss on ignition.
Mineralogical composition. Clay consists of one or more clay minerals - illite, kaolinite, montmorillonite, chlorite, halloysite, or other layered aluminosilicates, but may also contain sand and carbonate particles as impurities. Alumina (Al_2O_3) and silica (SiO_2) form the basis of the composition of clay-forming minerals, including the studied loess [2].
Studies of the influence of the mineralogical composition of clay raw materials, the type and content of pore-forming components on the properties of wall materials are not systematized and are empirical in nature [2].
The particle diameter in the clay is less than 0.005 mm; rocks composed of larger particles are classified as silt. The color is varied and is mainly due to impurities of chromophore minerals or organic compounds that color them. Pure clay is mostly gray or white, but red, yellow, brown, blue, green, purple, and black are also common [3].
As a rule, the rock-forming mineral in clay is kaolinite ($Al_4[Si_4O_{10}](OH)_8$), its composition: 47% (by weight) silicon oxide (IV) (SiO_2), 39% aluminum oxide (Al_2O_3) and 14% water (H_2O).
Melting point: 900-1600 and above °C
The mineralogical (material) composition includes clay matter and impurities.
Clay matter is a complex of clay-forming minerals, the most important of which are kaolinite, montmorillonite, and hydromica. Clay minerals also include halloysite, monothermite, beidellite, etc.
Kaolinite has particles with a size of 1-3 microns, it is not able to attach and firmly hold a large amount of water, and quickly releases moisture when dried. Kaolins with a small amount of impurities are refractory, moderately and slightly plastic, and have a light color. Pist = 1.8-2.2 g/cm3, stable in acidic environment.
Montmorillonite - has particles less than 1 micron in size. Intensively absorbs water, retains it firmly and is difficult to release during drying. When moistened, it swells strongly and can increase in volume up to 16 times, it is fusible, highly plastic.
Clay rocks dominated by montmorillonite minerals are called bentonites. *Bentonites* are highly plastic, give significant air shrinkage, are prone to cracking during drying and swelling during firing. Used as an additive to increase plasticity and binding ability.
Hydromica contains oxides of alkali and alkaline earth metals. The particle sizes are within 1 μm. Hydromicas are moderately or medium plastic, have a low sintering temperature.
Depending on the predominance of one or another clay mineral, kaolinite, hydromicaceous, montmorillonite, hydromicaceous-kaolinite, montmorillonite-kaolinite, montmorillonite-hydromicaceous and polymineral clays are distinguished, which contain three or more clay minerals.

Monotermite is a fine mechanical mixture of hydromica and kaolinite. Swelling and water absorption is stronger than that of kaolinites, it is a plastic refractory clay.
Impurities are all components of the clay rock that do not have the properties of clay minerals. Impurities can be carbonate inclusions, ferruginous minerals, alkaline oxides, organic impurities, gypsum, soluble salts, mica.
Granulometric (grain) composition - the quantitative ratio of particles of different sizes, fractions, expressed in% by weight.
A fraction is a group of particles of the same size. The granulometric composition is characterized by the content of clay fraction (smaller than 0.005 mm), dusty particles (0.005-0.14 mm) and sand (0.14-5 mm) in them. The ratio between these fractions determines such properties as plasticity, cohesion, shrinkage, and sensitivity to drying [4].
Determination of the content of fine fractions. Determination of the content of fine fractions was carried out according to GOST 21216.11-93. The data are given in table 1.2.

GRANULOMETRIC COMPOSITION OF RAW MATERIALS

Table 1.2.

Factions %						
№ Samp.	1000-63 piec.	63-10 piec.	10-5 piec.	5-1 piec.	<1 piec.	Summary
Samp.№1 Samp.№2	0,6 0,5	36,5 40,0	22,7 21,5	20,9 19,8	19,3 18,2	100,00 100,00

Samples of the studied loess belong to the low-dispersed group of clay raw materials.
The content of coarse-grained inclusions in loess samples was determined according to GOST 21216.4-93. The data are given in table 1.3. and testify that loess:
- according to the number of inclusions larger than 0.5 mm, it belongs to the group with a low content of such inclusions;
- according to the size of the predominant inclusions to the group with small inclusions.

Inclusions are represented by organic matter and carbonate grains 1-2 mm in size.
Information about the content of coarse-grained inclusions is given in Table 1.3.

THE CONTENT OF COARSE-GRAINED INCLUSIONS

Table 1.3.

Content of inclusions %					
№ Samp.	5,0mm	2,0mm	1,0mm	0,5mm	Type of inclusions
№1	0,160	0,240	0,220	0,130	Organic carbonates
№2	0,140	0,235	0,230	0,140	-«-

3. CONCLUSION

The raw material mass based on the loess of the «Lagan» deposit of the Fergana region is satisfactory in terms of molding properties, medium-plastic, sensitive to drying, low-melting; the optimal firing temperature is 1050 °C. Strength characteristics: $R_{sj.sr.}$ of sample No. 1 of the old quarry is 18.8 MPa. $R_{sj.sr.}$ of sample No. 2 new quarry is 18.8 MPa.
To improve the molding and physical and mechanical properties, it is recommended to introduce a lean additive (sand, or slag, or crushed broken bricks).
The traditional porousization of bricks is carried out by introducing sawdust into the raw mass. During firing, due to the high temperature, the sawdust contained in the raw material is burned out, and the resulting gases seep between the clay particles and form an extensive network of channels [5].
A study of the properties of cotton stalks showed that they have a sufficiently high water-holding capacity and calorific value during combustion. In addition, the ash formed during the combustion of cotton stalks contains amorphous silica in a fairly large amount.
The data obtained indicate the expediency of using this agricultural waste as an effective burnable additive in the production of ceramic bricks with a porous structure.
According to the above data, it can be seen that the raw material mass based on the loess of the Lagan deposit in the Ferghana region of this loess in its pure form can be used for the production of ceramic bricks of grade 75-100.
Thus, the conducted studies have shown the possibility of expanding the raw material base in the Fergana region for the production of ceramic bricks of a dense and porous structure using loess from the Lagan deposit in the Fergana region.

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