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# Energy–Saving Compositions of Masses of Ceramic Tiles from the Raw Material Resources of the Lower Amudarya Region

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**ABSTRACT:** The article investigates the physical and mechanical properties of ceramic tiles obtained from the raw materials of the Lower Amudarya region of the Republic of Uzbekistan, such as clay of the Kulatau deposit and dune sand of the Tuprakkala massif.

Based on the results of laboratory and pilot production tests, it was found that the obtained unglazed facade and floor tiles based on the developed optimal composition M–7 and glazed facing and facade tiles based on the developed optimal composition M–9, consisting of clay from the Kulatau deposit and dune sand of the Tuprakkala massif in terms of physical and mechanical properties satisfy the established requirements of the relevant GOSTs.

**KEYWORDS:** hydromicaceous clay, low–melting clay, low–melting flux, dune sand, ceramic tiles, facade tiles, chemical and mineralogical composition.

## INTRODUCTION

Today, high–quality ceramic tiles necessary for the needs of the Republic of Uzbekistan, such as floor, facade tiles and porcelain tiles, are imported in large quantities at the expense of hard currency. Despite the fact that the Lower Amudarya region has sufficient reserves of mineral raw materials, enterprises producing ceramic tiles have not yet been established in this region.

Based on this, the study of the physicochemical properties of new mineral raw materials available in this region of the Republic and the development of energy–saving compositions of ceramic tiles based on them are urgent tasks.

As is known, ceramic tiles occupy a fairly large place in the production of building materials and are produced on the basis of clay raw materials [1].

Quantity and granulometric composition of quartz, contained in the composition of ceramic tiles as an exhaust component, has a significant impact on the processes of sintering, phase formation and formation of the structure of the ceramic material [2].

It is known that ceramic masses with a high content of free quartz are sintered at high temperatures. Therefore, fluxing components such as feldspars, pegmatites, perlites, nepheline–syenites and others are introduced into the tile masses to reduce the sintering temperature, which form a significant amount of the liquid phase during firing [3, 4].

V.F. Pavlov [5, 6] showed a favorable effect of low–melting clays on the sintering process of ceramic masses during firing as a low–temperature fluxing component.

Clay from the Kulatau deposit, located in the Tuprakkala district of the Lower Amudarya region, is part of new deposits that have not been used previously in the ceramic industry. In connection with this, in this work we set the goal of developing ceramic tile compositions based on this clay.

In [7], we studied the suitability of Kulatau clay for the production of ceramic materials.

According to the classification of GOST 9169–75: Clayish materials for ceramic industry, the studied clay, according to the content of free silica, belongs to the group with an average content of free quartz, according to plasticity to the group of highly plastic clay raw materials, and according to fire resistance, the studied clay is fusible [8].

According to the data of X–ray analysis [8], Kulatau clay belongs to the class of hydromica–montmorillonite type clays, with an insignificant content of quartz, kaolinite, and glauconite. In addition, in the mineralogical composition of this clay, there are impurities of feldspar minerals, hematite, etc.

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Water absorption of samples prepared from a sample of Kulatau clay by the plastic method and fired at 950ºC is about 5%, water absorption of samples from samples of this clay fired at 1000ºC is less than 1%, and in samples of Kulatau clay fired at 1050ºC there are signs of overburning. This shows that, according to GOST 9169–75, this clay belongs to the class of highly caking raw materials with low–temperature sintering.

Thus, according to technological indicators, Kulatau clay is characterized by a short sintering interval. Therefore, when using it in the production of ceramic tiles, it is necessary to select additives that expand the sintering interval.

In [9], we also studied the prospects for using dune sands of the Tuprakala massif in the silicate industry of the Republic of Uzbekistan and concluded that dune sands of the Tuprakala massif containing about 30% finely ground feldspar in their composition, with a predominance of anorthite, are a valuable raw material for the production of silicate materials. With huge reserves in the future, they can become a promising raw material in the development of the ceramic industry of the Republic of Uzbekistan. In connection with this, its use in the composition of ceramic tiles as a quartz–feldspar component is expedient.

Therefore, in the development of experimental mass compositions, in addition to the clay of the Kulatau deposit, dune sand of the Tuprakkala massif was used. Thus, experimental ceramic masses are developed on the basis of available and new local raw materials of the lower Amudarya region, the Republic of Uzbekistan.

## MATERIAL AND METHODS

The technological properties of the obtained prototypes of ceramic tiles, based on the developed compositions, were tested according to generally accepted methods in accordance with GOST 27180–2019 in the ceramic industries of the CIS countries.

Tiled samples from the developed masses were prepared according to the generally accepted technology of ceramic tiles in laboratory conditions.

It should be noted that a series of experimental laboratory ceramic masses were developed and tested according to the classical ceramic technology in a semi–dry way. At the same time, the degree of grinding of the experimental masses was no more than 1% on sieve No. 0056. Samples of tiles 50x50x8 mm in size were prepared from press powders with a moisture content of 6–9%, pressed in a laboratory hydraulic press at a pressure of 20–40 MPa, then the samples were dried in a drying cabinet at 105–110°C, after which they were fired in a muffle furnace.

## RESULTS AND DISCUSSION

In order to study the effect of the ratio of Kulatau clay and Tuprakkala dune sand on the physical and technical properties of ceramic tiles, a number of experimental masses were made, and after preliminary studies, 11 experimental masses were isolated from them, with the best indicators for further more detailed studies. The charge compositions of the experimental masses of ceramic tiles are shown in Table 1.

**Table 1.** The charge compositions of experimental masses in the composition of Kulatau clay and Tuprakkala dune sand

| Mass indices | Name and content of raw materials mass % | | | |
|---|---|---|---|---|
| | Angren secondary raw kaolin | Angren clay | Kulatau clay | Tuprakkala dune sand |
| M–1 | – | – | 60,0 | 40,0 |
| M–2 | – | – | 57,5 | 42,5 |
| M–3 | – | – | 55 | 45 |
| M–4 | – | – | 52,5 | 47,5 |
| M–5 | – | – | 50,0 | 50,0 |
| M–6 | – | – | 47,5 | 52,5 |
| M–7 | – | – | 45,0 | 55,0 |
| M–8 | – | – | 42,5 | 57,5 |
| M–9 | – | – | 40,0 | 60,0 |
| M–10 | – | – | 37,5 | 62,5 |
| M–11 | – | – | 35,0 | 65,0 |
| M–ZM | 24 | 20 | The rest: Chirakchi pegmatite–30, May quartz sand–6, talc–4 and broken tiles–16. | |

**Note:** M–ZM is the reference composition of the factory production mass of the JV "Art Gloss Gallery" fired at 1100°C (for comparison).

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It should be noted that, in the composition of the experimental masses, Tuprakkala dune sand is used as a quartz–feldspar raw material to reduce shrinkage and expand the sintering range of the mass, also to create two component masses, excluding the separate addition of feldspar raw materials in the composition of the masses.

Experiments have shown that samples from experimental masses M–1, M–2, M–3, M–4, M–5 and M–6 at a temperature of 1000°C and 1050°C have higher water absorption rates compared to mass M–7, however the total shrinkage of samples from these masses exceeds (>5%) the established requirements for ceramic tiles. Samples from masses M–8 and M–9 are somewhat inferior in quality to samples from mass M–7.

Samples from masses M–10 and M–11 at a temperature of 1000°C and 1050°C have lower performance compared to samples from mass M–9, water absorption of samples from these masses (>5.1%) does not meet the requirements for facade tiles.

Based on the analysis of all the parameters of the tile samples of the studies carried out in laboratory and factory conditions, we have established the optimal compositions of the ceramic masses.

Experimental samples fired in laboratory conditions from mass M–7 at temperatures of 1000°C and 1050°C meet the requirements of GOST for facade and floor tiles, respectively. Under factory conditions in JV “Art Gloss Gallery” LLC, unglazed monochromatic tiles were obtained from the mass M–7, the above–mentioned firing temperatures, with a reddish–brown color, corresponding to the requirements of GOST for facade and floor tiles.

However, it should be noted that in glazed samples from the M–7 mass, bubbles appear in the glaze layer under factory high–speed firing conditions. This is due to the fact that, in high–speed firing conditions, under the condition of a relatively early mass compaction, carbonate and other gases do not have time to completely escape from this mass, and at the highest temperatures, these lagging gases in the mass, escaping through the glaze layer, lead to the appearance of defects on the surface of the product.

Experimental samples from mass M–9, fired in laboratory conditions at firing temperatures of 1000°C and 1050°C, meet the requirements of GOST for facing and facade tiles, respectively. Under factory conditions, in JV “Art Gloss Gallery” LLC, glazed tiles were obtained from mass M–9 at the above firing temperatures that meet the requirements of GOST for facing and facade tiles. At the same time, due to the relatively late compaction, there are no defects on the glaze layer of finished glazed samples from mass M–9 during high–speed firing.

Thus, unglazed facade and floor tiles can be obtained from the M–7 mass at firing temperatures of 1000°C and 1050°C, respectively. And from masses M–9 at firing temperatures of 1000°C and 1050°C, respectively, it is possible to obtain glazed facing and facade tiles with a dull glaze.

Experimental data show that the developed compositions in the composition of Kulatau clay and Tuprakkala dune sand lead to a decrease in the firing temperature of ceramic tiles by 100°C and 50°C compared to the reference factory masses of JV “Art Gloss Gallery” LLC. At the same time, samples from masses M–7 and M–9 have optimal physical and mechanical properties. Table 2 shows the physical and mechanical properties of ceramic tiles from the optimal masses M–7 and M–9.

**Table 2.** Physical and mechanical properties of ceramic tiles from experienced masses

| Physical and mechanical properties of ceramic tiles (unglazed) from the optimal mass M–7 | | | | | |
|---|---|---|---|---|---|
| Indicators | Mass indices, % | | | GOST requirements | |
| | M–ZM | M–7 | M–7 | GOST 13996–93 for facade tiles (wall) | GOST 6787–2001 for floor tiles (unglazed) |
| Firing temperature, °C | 1100 | 1000 | 1050 | – | – |
| Water absorption, % | 7,89 | 4,8 | 2,5 | at least 2<br>no more than 9 | no more than 3.5 |
| Frost resistance, number of cycles | – | 53 | 59 | at least 40 | at least 25 |
| Bending strength, MPa | 15 | 26 | 33 | at least 16 | at least 28 |
| Wear resistance (for quartz sand), g/cm2 | – | – | 0,14 | – | no more than 0.18 |
| Physical and mechanical properties of ceramic tiles (glazed) from the optimal mass M–9 | | | | | |
| | Mass indices, % | | | GOST requirements | |

| Indicators | M–ZM | M–9 | M–9 | GOST 6141–91 for facing tiles | GOST 13996–93 for facade tiles (wall) |
|---|---|---|---|---|---|
| Firing temperature, °C | 1100 | 1000 | 1050 | – | – |
| Water absorption, % | 7,89 | 6,4 | 4,0 | no more than 16 | at least 2<br>no more than 9 |
| Frost resistance, number of cycles | – | 43 | 54 | – | at least 40 |
| Bending strength, MPa | 15 | 22 | 27 | at least 15 | at least 16 |
| Thermal resistance of glaze, °C | 155 | 160 | 175 | at least 150 | at least 125 |

## CONCLUSION

Thus, based on the results of the pilot production tests, it can be concluded that the obtained unglazed facade and floor tiles based on the developed composition M–7 and glazed facing and facade tiles based on the developed composition M–9, consisting of clay from the Kulatau deposit and dune sand of the Tuprakkala massif in terms of physical and mechanical properties and economic efficiency are optimal compositions that meet the established requirements in accordance with GOST 13996–93: Facade ceramic tiles and carpets from them. Specifications, GOST 6787–2001: Ceramic tiles for floors. Specifications and GOST 6141–91: "Ceramic tiles for interior wall cladding. Specifications.

## REFERENCES

1. Avgustinnik A.I. Ceramics. L .: Stroyizdat, 1975. - p. 592.
2. J.L. Amoros, M.J. Orts, S. Mestre, J. Garcui-Ten., C. Feliu. Porous single fired wall tile bodies: Influence of quartz particle sizeon tile properties // Journal of the European Ceramic Society. – Vol. 30. - No. 1., 2010. - p. 17–28.
3. F. Andreola, L. Barbieri, F. Bondioli, I. Lancellotti, P. Miselli, A. Ferrari. Recycling of screen glass into new traditional ceramic materials // International Journal of Applied Ceramic Technology. – Vol. 7. - No. 6., 2010. - p. 909–917.
4. A.M. Eminov, I.R. Boyzhanov, R.G. Allamov, S.K. Duschanov A.M. Clays of the Gurlenskoe deposit - a new raw material for the production of ceramics // Composite materials, No. 3, 2019. - p. 101–103.
5. Pavlov A.F. Fusible clays in ceramic masses // Glass and ceramics. 1983. - No. 9. - p. 17–18.
6. Verichev E.N., Pavlov V.F. Acid-resistant masses with the addition of fusible clays // Glass and Ceramics, No. 2, 1981. - p. 15–16.
7. A.M. Eminov, I.R. Boyzhanov, Zh.S. Zhabberganov, R.G. Allamov, D.B. Matkarimova. Clay of the Kulatau deposit is a new raw material for the production of ceramic plates // International scientific and scientific-technical conference on the topic "Innovations in construction, structural and seismic safety of buildings and structures". Namangan, 2021. - p. 73–74.
8. A.M. Eminov, I.R. Boyzhanov, Zh.S. Zhabberganov, R.G. Allamov. The use of clay from the Kulatau deposit to obtain facade slabs // Electronic journal of actual problems of modern science, education and training. No. 12/2, 2021. http://khorezmscience.uz.
9. Zhabberganov Zh.S., Eminov A.M., Boyzhanov I.R., Duschanov S.K. Dune sand of the Tuprakkala massif as a raw material for the production of ceramic plates // International Scientific and Technical Conference dedicated to the International Year of Glass "Innovative technologies for the production of glass, ceramics and binders". Tashkent, 2022. - p. 54–55.

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