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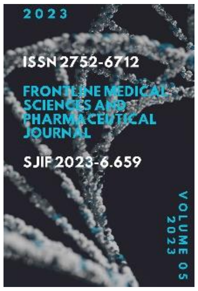

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Research Article

RESEARCH ON METHODS TO REDUCE THE MICROHARDNESS OF MARBLE AGGREGATES IN THE INSTALLATION OF MOSAIC FLOORS

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ABSTRACT

This article describes the properties of the degradation of the surfaces of brittle and plastic-brittle materials belonging to marble, the characteristics of a crushing body, parameters of accelerated loading, and effects associated with the external environment in which grinding is performed. When applying to marble aggregates in mosaic coatings, primarily abrasive erosion occurs, and a large number of surfaces of cemented abrasive grains are removed through grinding binders, ie, the process of micro scratching.

KEYWORDS

Abrasive wear, marble, microcracks, filler, microhardness, restoration methods, research.

INTRODUCTION

We can see mosaic floors mainly in industrial buildings, shopping centers, offices, medical and educational institutions, service stations, car washes and other buildings[1-2].

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Unlike conventional concrete floors, mosaic floors are architecturally attractive, impact-resistant, moisture-resistant, environmentally friendly and hygienic (Fig. 1 a, b).

Another important point is that there is no risk of sparking on marble tile floors, which means they also meet fire safety requirements. For mosaic flooring, more crushed marble chips are used.

a b

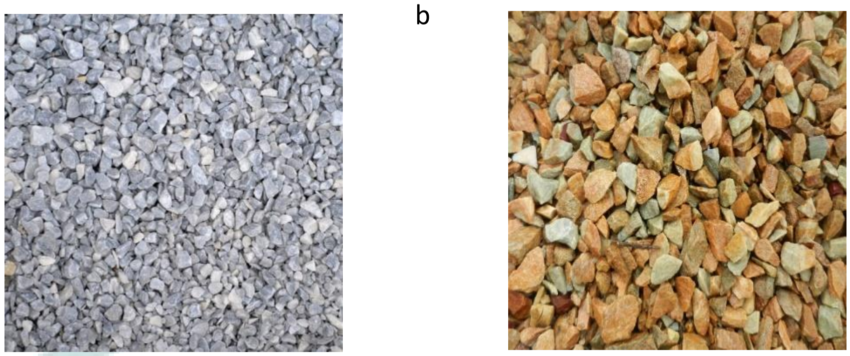

Figure 1. Marble fragments: a-large gray, b-small yellowish-white.

Fully crystalline marble and marbleized limestone are used in the construction. Marbled limestones are polished and are transitional rocks from limestone to true marble.

There are dozens of marble quarries in Uzbekistan and other places, from which marble blocks with a crushing strength limit of 6 to 12 kPa are obtained for construction. Mineral calcium is considered as the main rock in marble, and its content varies from 85 to 89.8%.

Four marble quarries were used as raw materials in the study of marble grinding, from which marble lumps were supplied mainly to construction organizations. The physical and mechanical properties of marbles from the mentioned deposits are presented in Table 1. The data in this table are based on the average values of the test results of five samples taken from each mine. The experiment was conducted mainly using marble from the Almalyk mine. Data on other deposits were obtained based on analysis from various technical literature (Table 1) [3].

Table 1

The main physico-mechanical properties of the studied marble rocks and decorative features

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No t / b	Mining site	Rock color	Density , g / cm ^{3}	Bulk density, g/cm ^{3}	Mus - strength limit in crushing , kPa	Micro-hard - lik, N / mm ^{2}	Porosity, %
1.	Almalik (Uzbek.Resp .)	White with a yellow tint	2.7	2.64	6.47	149.2	1.7
2.	Koelgin (Urals)	White color	2.71	2.68	6.53	144.3	1.1
3.	Navoi village. Gozgon marble mine	Blonde-ok	2.72	2.63	6.51	141.2	1.6
4.	Samarkand region Zarband marble mine	There are gray dark streak spots	2.75	2.68	6.46	147.3	1.5
5.	Tashkent city. Aksokota marble mine	White-yellow bump-shaped	2.69	2.62	6.56	146.5	1.2
6.	Ufaley (Chelyabinsk)	Blue-brown	2.75	2.7	10.79	159.7	1.72

The analysis of technical literature data in this field and specially conducted experimental studies made it possible to obtain the preliminary evidence needed to evaluate the speed of the grinding process of marbles bonded with abrasives (Table 2). Based on the obtained data, it was determined that the speed of the marble grinding process depends on their microhardness, the description of abrasive elements and other parameters:

$$\tau = \frac{Q_м}{1{,}76 K_1 K_2 V (q_a / H_м)^{\alpha}}, \text{ here}$$

τ- grinding time, minutes; $Q_м$ – depth of engraving, mm;

K_1 – coefficient depending on the type of marble;

K_2 ; _ α- coefficients depending on the description of abrasive elements.

$$K_2 = \frac{S_1}{S_2} \cdot h_{max}^2 \cdot C\left(\frac{1}{в}\right)^{\alpha} \cdot Z; \quad \alpha = \frac{2}{\nu},$$

ν- tube cutting speed, mm /min;

q_a – relative pressure of abrasive elements on the marble surface, N /mm ^{2};

h_m - micro thickness of marble , N /mm ^{2};

S_1 – the working area of the abrasive element of the sili q lashing machine, mm ^{2};

S_2 is the cross- sectional area of the traverse in one revolution , mm ^{2};

H_{max} - maximum height of roughness of abrasive grains, mm;

S - the number of abrasive grains on the surface of the abrasive element , grain /mm ^{2};

в , - νparameters of the base curve q

$в = 1 \div 6; \qquad \nu = 0{,}5 \div 2;$

Z - the number of abrasive elements, pieces;

K_1 , K_2 and - coefficients αmaintain constant values for a certain type of marble and type of abrasive element was confirmed by comparing the theoretical and experimental data obtained in grinding marbles (Fig. 2) .

Can be seen from the formula that polishing and hardness decrease with increasing polishing rate and relative pressure and increase with increasing marble microhardness [4-8].

But when increasing the speed and relative pressure, the energy consumption increases dramatically. The most appropriate way to reduce the microhardness of marble in the pre-fracture zone is that the current device does not increase the energy costs of the grinding process.

Table 2

Microhardness of the marble grinding process speed preliminary data for evaluation

The name of the values	Calculation formula or symbol	Unit of measure	Reminder
1	2	3	4
The ratio of the depth to the width of the abrasive element that leaves a single grain in the marble	K 1	-	$K_1 = 4{,}5 \div 6$ depending on the micro-hardness of the marble
The average length of the corridor	$\ell = 7{,}03R = \ell_{ўрт} \cdot 2\pi R$	mm	$\ell_{ўрт} = 1{,}12$ R - the radius of the grinding machine, mm
The maximum depth of the corridor	$t^2_{\max} = (\frac{q_a}{bH_м})^{\frac{2}{\nu}} \cdot h^2_{\max}$	mm	b , ν- t a yanch curvature parameters; ν=0.5 ÷2; b =1 ÷6 h max is the maximum height of the abrasive grain
The working area of the abrasive element of the grinding machine	S 1	mm 2	-
The number of revolutions of the traverses of the machine	N	min /_	

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			-
Smoothing speed	ν	mm /min	ν=n ·R
grains on the surface of the abrasive element s oni	C	piece /mm ^{2}	According to literary sources
The number of abrasive elements	Z	piece	-
Relative shearing of marble during polishing	$Q_y = \frac{1}{4} \cdot K_1 l \cdot t_{max}^2 \cdot S_1 \cdot C \cdot n$	mm ^{3}/min	-
Cutting depth per minute	$Q_м = \frac{Q_y}{Q_г}$	mm /min	S_2 is the grinding area of the traverse in one rotation, mm ^{2} $S_2 = \left[R^2 - \left(R - \frac{d}{2} \right)^2 \right]$
Conditional diameter of the abrasive element	D	mm	-

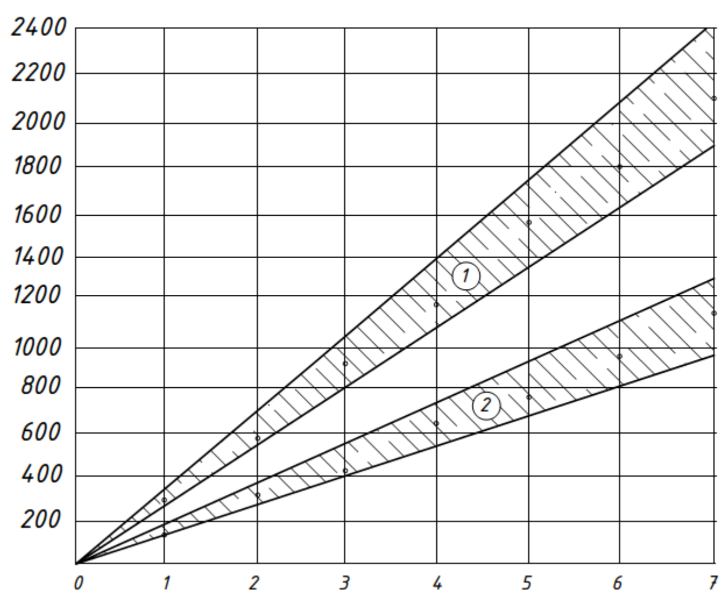

Figure 2. Experience in the speed of grinding marbles and

results of comparison of theoretical data.

The lines in the drawing are the zone of theoretical calculations;

points in the drawing are KCh-40-S $_1$ -B type abrasive elements

used experimental data.

1- microhardness marble that is N $_m$ =172.8 N /mm^2;

2- microhardness marble that is N $_m$ =142.0 N /mm^2

A study of possible methods of reducing the microhardness of marble filler in grinding showed that the highest efficiency is achieved in the presence of surfactants (PS).

Result. On the basis of the initial scientific and research work, it was possible to develop an improved method and technology for polishing mosaic floor covering with surface-active substances.

To determine the polishing time of the mosaic coating, the marble samples were first sanded to create a uniform roughness before testing. Table 3 shows the results of the measured value of the time for grinding marbles from different quarries depending on the thickness of the layer to be removed.

Table 3. Marble grinding time, in minutes

Marble quarry site	The total thickness of the obtained layers, mm							
	0.5	1	2	3	4	5	6	7
German (Uzb. Respub.)	99.3	198.0	395.6	594.3	792.5	989.6	1187.3	1386.1
Koelgin (Ural)	80.1	160.6	319.8	479.1	541.3	701.5	859.1	1019.4
Navoi village. Gozgon marble mine	150.2	298.9	601.3	900.6	1201.3	1509.1	1812.0	2103.5
Samarkand region Zarband marble mine	88.1	170.6	419.8	679.1	541.3	701.5	859.1	1019.4

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Tashkent city. Aksokota marble mine	106.3	178.7	376.6	594.3	792.5	867.6	1217.3	1386.1

From the analysis of the data in Table 3, it can be seen that if marble is polished in a layer of 7 mm thickness, it is polished 2.5 - 4.5 times slower than cement stone in 14 days. In addition, marbles from different quarries are polished differently.

Marble from the Koelgin mine is the easiest to grind, and although the value of the limit of crushing strength is higher than the marble from the Almalyk mine, it was found to have a lower hardness.

This situation can be explained in such a way that the strength of marble depends not only on its mineralogical composition (percentage of calcite) and structure, but also on the presence of microcracks in different layers of the marble body, which affect their grinding to a lesser extent.

Grindability of mosaic coverings was studied with one mass part of gray portland cement and three mass parts of marble with fractions of 2.5–5 mm, 5–10 mm and 10–15 mm.

Only marble from the Almalik mine was used for the experiment. The information on the marble mines obtained by Q is taken from the technical literature.

Marble chips were obtained by grinding the boards studied in marble grinding . For each series of tests, three sample boards were prepared and stored under the same conditions as the cement stone samples.

The samples were tested after every 5 and 14 days of curing period. In order to determine the state of change of the results between the specified storage periods, samples from the marble blocks of the Almalyk mine were tested for a period of 7 days.

Figure 3 shows the curve graphs of the grinding speed of the mosaic pavement constructed from marble chips from different quarries. In this case, graphs are constructed based on the average values of three samples. As can be seen from the graphs, the position of the curves is similar to the change during grinding of cement stone. The surface layer of the mosaic coating is removed faster than the main one, because this layer is mainly composed of cement stone.

The smoothness of the coating largely depends on the age of the cement stone.

The graphs in Figure 4 show the curves of the time of removal of the 7 mm layer of the marble mosaic covering and the cement stone taken from the Almalyk mine. Here, the dependence on the duration of endurance of samples under standard conditions is taken into account. The characteristics of the curves show that increasing the age of the mosaic coating from 5 to 14 days results in a sharp increase in its polishing time. When the coating is stored for more than 14 days, the time consumption increases significantly, because the future compressive strength and hardness of the cement stone increases much more slowly compared to the initial period.

Comparing the grinding time of the mosaic floor at different ages with the grinding time of cement stone and marble from different quarries, a very interesting result is revealed [9].

It turns out that the time required to obtain a 7 mm thick mosaic coating, that is, when there is an average saturation level of 60-70% of the marble surface, is relatively less time spent in obtaining a layer of such a thickness of marble. It was almost 15 times less for a 5-day floor covering, 6 times less for a 7-day floor covering, and 3 times less for a 14-day floor covering compared to a marble surface .

In order to determine the reason for this situation, profilograms were taken from the surfaces polished to a thickness of 3-5 mm from the mosaic coating samples aged 5, 7 and 14 days. Profilograms were obtained using the profilograph-profilometer "Kalibr - VEI" according to the following methodology. On the surface of the samples, a conditional straight line of 3-5 cm is marked at the beginning and end (notched line), which passes along the grain of the filler and the cement stone.

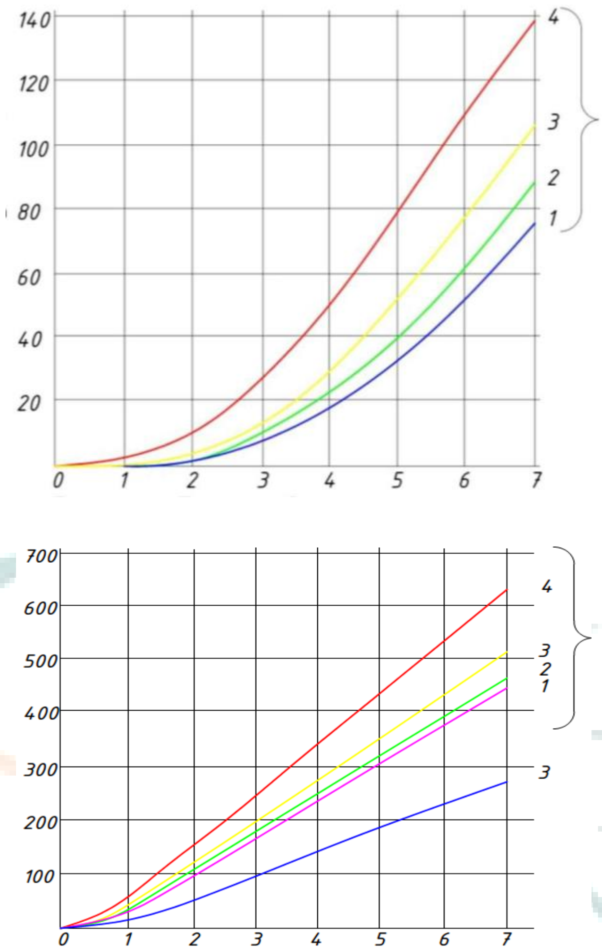

Figure 3. Polishing of marble floor tiles from various quarries:

a – 5-day floors; b – 7- and 14-day floors.

1 – Koelgin marble pieces from the (Ural) mine ;

2 – Marble blocks taken from Olmali mine (Uzbekistan) ;

3 – Ufaley (Chelyabinsk) marble pieces taken from mine ;

4 – Stepnokert Marble pieces taken from (Armenia) mine .

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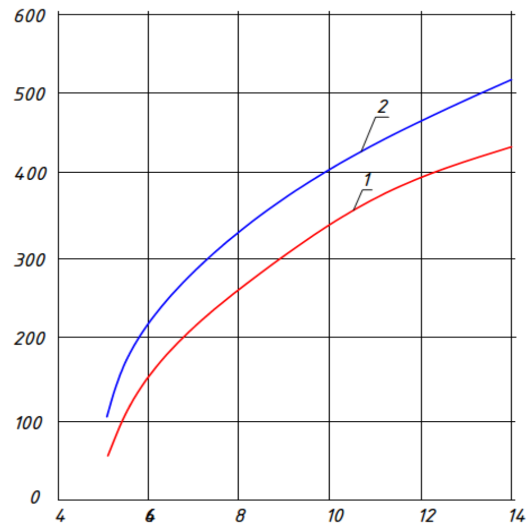

Figure 4. There were pieces of marble taken from the Almalyk mine it is similar to the age of mosaic tiles and cement stones the relationship between tuberculosis and cancer.

1 - cement stone; 2 - Mosaic tile floor with marble pieces from the Almali quarry.

Note: the thickness of the removable sanding layer is assumed to be 7 mm.

A steel ruler is placed on the grooved line, and a needle probe slides along its edge. The needle can copy the surface of the sample, and its cross-section (profile) is automatically recorded on a special tape with a vertical magnification of 1000 times and a horizontal magnification of 20 times.

Figures 5a, b and c show the most significant parts of the profilograms at the boundary between marble and cement stone.

Discussion. Analysis of the profilograms shows that the profile characteristics of the mosaic coatings at 5, 7 and 14 days are similar.

The surface of the marble filler protrudes from the surface of the cement stone. The difference in surface levels varies within 30-40 microns. Consequently, it can be assumed that during the grinding process, the cement stone wears faster and exposes the protruding grain of the filler. In this case, the abrasive stone directly contacts the surface of the filler particles and presses the crushed powdery product (slurry) into the grooves formed in the body of the cement stone.

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The formation of grooves causes a sharp increase in the relative pressure on the marble fillers and eases the grinding process. As a result of this, rapid corrosion of marble occurs.

At this time, the slurry helps the cement stone to crumble. Abrasive stone is the slurry in the grooves, which in turn is abrasive to the cement stone as a fine particle of marble. All these phenomena lead to the fact that the time required for polishing mosaic tiles is much lower than for polishing marble.

It is known that the analysis of profilograms shows that the surface of the aggregate grain is raised by 30-40 microns from the surface of the cement stone. This means that when grinding, the relative pressure from the abrasive elements of the grinding machines affects practically only the marble filler, and not the entire area of the mosaic coating placed under the elements, as in the case of grinding homogeneous objects. This creates increased pressure on the filler grains and dramatically increases the speed of obtaining the mosaic coating. In this case, the cement stone is polished with a free abrasive. This abrasive role is performed by crushed grains of marble, cement stone and abrasive elements, and their mixture with water is called slurry.

The direction of future research in the direction of studying the influence of various technological factors on the speed of the marble grinding process related to the determined characteristics of the mosaic coating process and the special case of abrasives was determined.

In particular, the filler (marble) has the main effect on the rapid removal of the coating to start grinding the cement stone with a reasonable consistency (hardness).

a)

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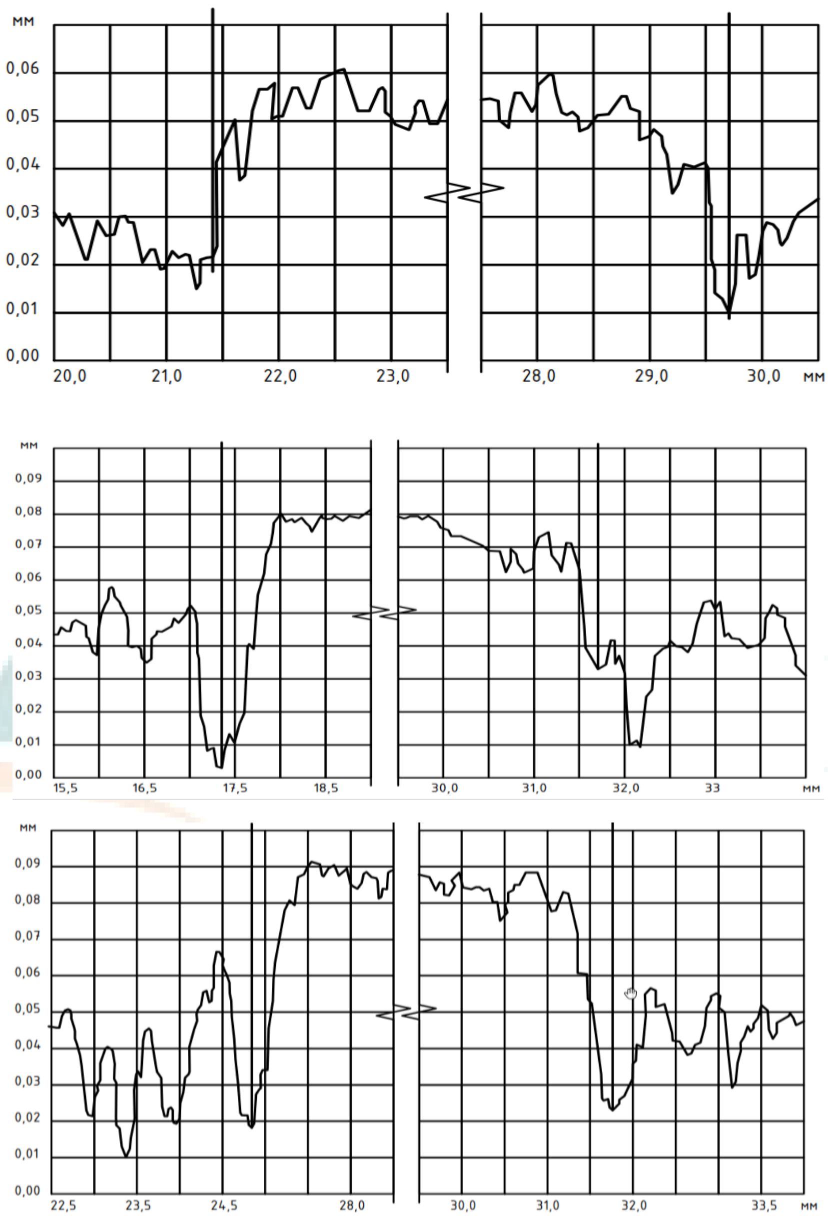

Fig. 5 a, b and c. Profilograms of a mosaic coating at the boundary between marble and cement stone.

a - 5 days; b - 7 days; c – 14 days.

Conclusion

The surface damage characteristics of brittle and plastic-brittle materials related to marble may vary depending on the characteristics of the body to be polished, loading-acceleration parameters, and the external environment in which the grinding is carried out.

In mosaic coatings, abrasive wear occurs first when applied to a marble filler. Therefore, grinding with the help of binders is seen as a process of microscratches on the surface of a large number of cemented abrasive grains.

The smoothness of the mosaic coating mainly depends on the hardness of the marble filler. The time of grinding the coating in 4-5 days is determined by the time of grinding the marble. Therefore, finding ways to speed up the marble grinding process is a major practical issue.

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