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Evalution of Salt Crystallisation Effects on Artificial Marble

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Abstract

Utilisation of artificial marble in the construction industry is widespreading because of it has got very low porosity show very good performance and homogeneity, color consistendency and mechanical strength. Construction and building materials are exposed to various physical, chemical and environmental interactions and they were subjected to various atmospheric, climatic and seasonal effects. Some of these effects are atmospheric pollution, natural geochemical and physical processes-slow dissolution by rain water, salt deposition and recrystallization, freeze-thawing cycles, spalling, climatic factors, air pollution, industrial pollutant, chemical contaminants, solar radiation, (notably acid rain), bio deterioration and thermal effects. These effects can cause deteriorate partially or completely and changes marketability of natural building stones. In this study two commercially available and extensively used artificial marble were subjected to salt crystallization ageing test according to TS EN 12370. Test samples subjected to 14% $Na_2SO_4.10H_2SO_4$ solutions. The changes in physical and color properties L,a,b) and glossiness of samples has been determined and evaluated. Experimental results showed that, salt crystallization has led to changes of weight, porosity, unit weight and color and glossiness. Weight, glossiness decreased as the whiteness (L), redness (a), yellowness (b), porosity increased.

Key Words: Salt crystallisation, artificial marble, colour, weight changes.

1. Introduction

As one of the earliest building materials, natural building stones are often known as symbols of durability and continuity. However, depending on the different uses and locations of the stones, direct or indirect environmental interactions have been found to be subject to eventual degradation.

Natural stones are exposed to many deterioration conditions such as time, solar radiation, temperature changes, atmospheric pollutant etc. These factors caused to deterioration of natural stones timely. Loss of materials, flaking, exfoliation even the complete disaggregation of materials [1]. Depending on the environmental factors, the mechanism of disintegration can be considered under three main headings as physical, chemical and biological disruption.

In order to prevent degradation in rocks, the factors causing the degradation must be determined in detail. Today, it is possible to see much work on the determination of the factors that cause decomposition and the studies about earthquake, fire, water pressure, wind, freeze-dissolution, temperature fluctuations, chemical materials, pollution, salt crystallization and biological degradation which are increasingly working and causing decomposition. One of the most important factors that change the properties of rocks due to the effect of air and water is the non-recycling reactions of rock masses due to natural and artificial reasons [2].

1.1. Artificial marble

Artificial marble is homogeneus construction materials which made of polyester and mineral fillings, can be processed in three dimensions and have got high mechanical strength, resistant to different chemical and temperature conditions. Artificial marble is more elastic and mechanically more resistant than natural marble and granite. After the mixture is prepared for the material, it is poured into molds prepared by oiling beforehand. Then, after the produced product has been left for two or three hours, the mold is disassembled and subjected to grinding. The finished product is cleaned and is ready for marketing [3].

2. Materials and Methods

2.1. Samples

Two artificial marble were chosen for this study. The polished surface and 40 ± 1 mm sized samples were collected marble processing plant in Turkey.

2.2. Salt Crystallisation Test

Salt crystallization test were carried out suggested by TS 12370 [4]. For the experiments, 6 specimens 40 ± 1 mm were prepared and subjected to %14 Na_2SO_4.10 H_2O, solutions during 30 days. Before beginning the cycle, the samples were dried to a fixed mass of 105 ^oC and cooled in a desiccator weighed and. Then, it was immersed in 14% Na_2SO_4.10 H_2O solution

prepared and left in solution at (20 ± 0.5) ° C for 2 hours. At the end of the waiting period, the samples were removed from the solution and the sample was dried. During the experiment 30 cycles were applied. After the treatment, the samples were taken from the oven and kept in (23 ± 5) ° C water (24 ± 1) hours and finally washed thoroughly in tap water. Color and gloss measurements were taken at the surface of the samples at the beginning of the cycles and at the end of each five cycles.

2.2.1. Determination of colour changes

In this study color measurements was done Hunter CIELAB colorimeter device. Color parameters are defined L, a, b. L parameter define is blackness- whiteness (L: 0 black, L:100 white), a parameter defines redness-greenes (a>0 red, a<0 green), b parameter defines yellowness- blueness (b>0: yellow, b<0: blue).

2.2.2. Determination of gloss changes

In this study the gloss measurement was done using a Q TQC GL0010 60^0 solo glossmeter at 60^o angles for each sample.

A gloss- meter sends light at a certain angle to the surface and determines the surface gloss numerically based on the reflection angle of the light. It can be done on rough surfaces. Gloss-meters are less sensitive to vibrations and seem to be partially appropriate for quality-control measurements conducted in commercial facilities [5]. Gloss values are expressed in GU (gloss units).

3. Results

At the end of the salt crystallization cycles, color changes occurred. The results of the color measurements taken before the start of the experiments and at the end of each 5 cycles are given in Table 3.1-. 3.3, gloss measurement results were given in Table 3.4, weight measurement result were given in Table 3.5. Values in % of the total change in the samples were given in Table 3.6.

Table 3.1.Initial, intermediate and final data of L values

Sample	İnitial L value	End of the 5. cycle	End of the 10. cycle	End of the 15. cycle	End of the 20. cycle	End of the 25. cycle	End of the 30. cycle
Ç1	78,55	76,825	77,07	78,24	78,08	78,125	77,945
Ç2	89,12	88,373	88,98	88,89	8,87	87,16	88,60

Table 3.2. Initial, intermediate and final data of a values

Sample	İnitial a value	End of the 5. cycle	End of the 10. cycle	End of the 15. cycle	End of the 20. cycle	End of the 25. cycle	End of the 30. cycle
Ç1	4,93	5,27	5,45	5,45	5,61	5,71	5,76
Ç2	0,52	0,87	0,89	1,006	1,116	1,183	1,24

Table 3.3 Initial, intermediate and final data of b values

Sample	İnitial b value	End of the 5. cycle	End of the 10. cycle	End of the 15. cycle	End of the 20. cycle	End of the 25. cycle	End of the 30. cycle
Ç1	15,6	15379	16,81	16,46	16,70	17,14	17,38
Ç2	3,82	7,68	8,276	8,53	8,79	9,02	9,23

Table 3.4. Initial, intermediate and final data of gloss values

Sample	İnitial gloss value	End of the 5. cycle	End of the 10. cycle	End of the 15. cycle	End of the 20. cycle	End of the 25. cycle	End of the 30. cycle
Ç1	2,185	1,875	1,84	2,02	2,13	2,13	2,10
Ç2	2,473	1,87	1,99	2,19	2,32	2,36	2,35

Table 3.5. Initial, intermediate and final data of weight values

Sample	İnitial weight value	End of the 5. cycle	End of the 10. cycle	End of the 15. cycle	End of the 20. cycle	End of the 25. cycle	End of the 30. cycle
Ç1	103,475	103,45	103,425	103,42	103,395	103,367	103,365
Ç2	138,923	138,783	138,753	138,69	138,71	138,67	138.66

Table 3.6. Values in % of the total change in the samples

Sample	Δ_L (%)	Δ_a (%)	Δ_b (%)	Δ_{gloss} (%)	Δ_{weight} (%)
Ç1	-0,776	16,82	11,41	-3,89	-0,106
Ç2	-0,583	138,46	141,62	-4,83	-0,189

As can be seen in Table 3.1-3.6, cycle progressions led to a decrease of the surface gloss, sample weight, and L value. As the salt crystallization cycles progressed, the L value in both of the samples decreased, so the colors of the samples became darker. On the other hand, the values of a and b increased. Especially in the case of Q2, this increase is more. Yellowing and redness developed in both samples. The decrease in surface glosses has been evidenced by these color changes in the samples. In addition, due to the internal pressures created by the salt crystallization, microfracture develops, and weight losses are caused by breakage and breaking.

4. Conclusions

In this study, salt crystallization effects of $Na_2SO_4.10\ H_2O$ in artificial marbles were investigated. For this purpose, 30 salt crystallization cycles were performed on two different artificial marbles. At the end of each five cycles, color, surface gloss and weight changes in the specimens were determined by measurements Darkening of the specimens resulted in increased redness values, decreased brightness and weight.

5. Acknowledgement

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6. References

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