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Midyat Yapı Taşlarının Tuz Kristalleşmesine Karşı Direncinin Belirlenmesi

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ÖZ

Tuz kristalleşmesi, farklı ortamlarda gerçekleşen ve kayaçları etkileyen önemli bir kaya bozunma sürecidir. Tuz kristalleşmesine bağlı bozunma, özellikle gözenekli kayaçlar üzerinde etkili olmakla birlikte çatlak ve mikroçatlaklar içeren kayaçlar üzerinde de önemli etkilere sahiptir. Bu çalışmada, farklı mevkilerden elde edilen ve yapı taşları olarak kullanılan altı farklı Midyat taşının tuzlu kristalleşmesine karşı dirençleri kuru ağırlık kaybı testi kullanılarak belirlenmiştir. Testler laboratuvar ortamını taklit ederek doğal çevreye uygun olarak gerçekleştirildi. Elde edilen veriler, Midyat taşının tuz kristalleşmesinden etkilendiğini göstermiştir.

Anahtar Kelimeler: Tuz kristalleşmesi, Yapı taşları, Midyat taşı, Kuru ağırlık kaybı

Determination of the Resistance of Midyat Building Stones to Salt Crystallization

ABSTRACT

Salt weathering is a process of rock disintegration that takes place in a variety of environments and affects many kinds of rocks. Weathering due to salt crystallization is particularly effective on porous rocks. It also has important effects on rocks containing cracks and microfractures. In this study, the resistance against salt crystallization of six different Midyat stones used as building stones, obtained from different locations was determined by using dry weight loss test. The tests were carried out in accordance with the natural environment by simulating the laboratory environment. The obtained data show that Midyat stone is affected by salt crystallization.

Keywords: Salt crystallization, Building stones, Midyat stones, Dry weight loss

1.INTRODUCTION

Weathering; is generally defined as the degradation of rocks under the direct influence of hydrosphere and atmosphere (Fookes et al., 1971; Unver and Unal, 1995). Depending on the environmental factors, the mechanism of disintegration has been grouped into three main groups by many researchers: physical alteration, chemical and biological degradation (Beaves, 1985; Jhonson and Degraff, 1988).

Many fields and laboratory studies have shown that salt weathering is an important mechanism of rock decay (Goudie, 1993; Goudie and Viles, 1997; Goudie,1999). Salt-related degradation is seen especially in hot and arid climates, especially around the seas, in widespread climatic conditions. Salts function as the strongest degradation material when combined with the wind in these specified environments (Doornkamp and Ibrahim, 1990; Jefforson,1993; Benaventa, et al., 2001). Salts interact with building blocks through factors such as rain, humidity, and fog.

The damage of the salts on the rocks is usually due to these two factors, the crystallization and the hydration of the salts. The crystallization pressure is defined as the most important mechanism of disintegration in the order of crystallization, depending on the solubility of the solution and the size of the pores of the rock (Jefferson, 1993; Rodriguez-Navarro, C. & Doehne, E., 1999; Rodriguez-Navarro, C. & Doehne, E.,et al, 2000; Benavente et al.,2007). Degradation due to salt crystallization is particularly effective on porous rocks, but also on rocks containing cracks and microcracks (Benavente et al., 2003). The salts in the porous media cause the cementation between the granules and the binder material to weaken. Dissolution and crystallization cycle causes weight loss in rock, change in grain and pore sizes, the degree of alteration and visible surface decay (Benavente et al.,2001; Benavente, et al., 2003). As a result, the rock properties, environmental conditions and salt properties of the rocks in the salt-induced degradation are the parameters studied (Sperling and Cooke, 1985; Goudie, 1993).

Salt degradation of building stones is considered one of the primary agents in the loss of building Stone and historical architecture (Smith et al., 1988; Winkler, 1994; Rothbert et al,2007; Ahmad et al, 2012). Many structures in the archaeological sites have also suffered from this process (Goudie, 1977). The Anatolian geography, which has a rich history in terms of historical and cultural structure, is under the influence of this process of disintegration. This study has been used as a building stone in a rich region in terms of historical and cultural structure and it has been carried out on the rock which is still used today. The chemical, physicomechanical properties of natural building stones taken from six different stones and their resistance to salt were tried to be determined by weight loss calculation. The experiments were performed in a laboratory environment. The obtained data show that Midyat building stones are significantly affected by salt crystallization.

2. MATERIALS

Six different building stone samples were used in the experiments (Figure 1). The test specimens were prepared in accordance with the test standards from the blocks taken from the quarries in the Mardin-Midyat region. Mardin-Midyat region (Figure.2) is located in the southeast of Anatolia. The physical and mechanical properties of the limestones in the region, which has been widely used in the past and today (Figure 3), have been studied by some researchers (Adin, 2007; Kaya, 2008).

Figure 1. Specimens used in the experiment

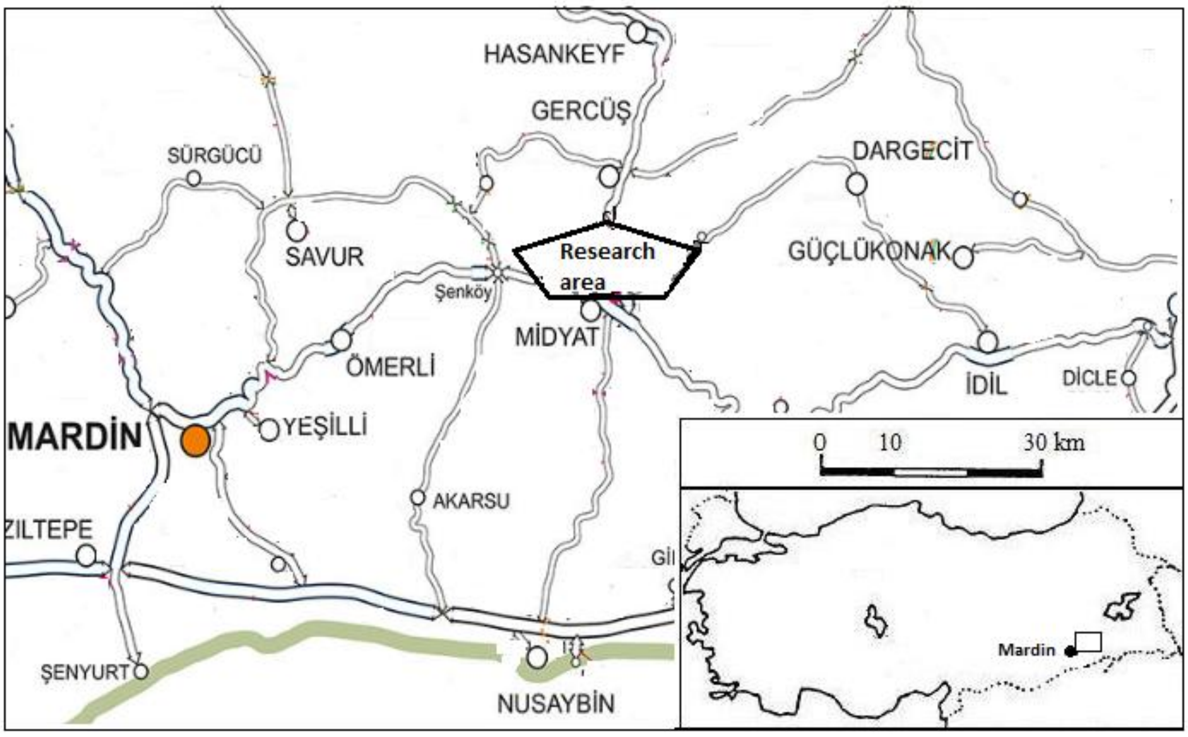

Figure 2. Location map of Mardin - Midyat region

The units in the area where the stone quarry operations are located are classified as Upper Cretaceous-Paleocene Germav formation, Lower Eocene Gercüş Formation, Eocene Midyat Formation and Quaternary aged alluvium. The Middle-Upper Eocene aged Midyat Formation forms the source of Midyat stone (Şimşek, 1979). The limestones studied in this study are extracted from the tops of the low plateau plains. Starting from the center of the Midyat district, it expands northward. There are a large number of quinces within these limestones. It has been understood that a stone newly removed from the quarry can be easily processed and exhibited a very soft property and that it gradually hardened starting from the surface and the pore structure decreased relatively (Kaya et al., 2008).

Figure 3. Views from historical and new stone buildings

3. METHODS

3.1 Chemical, physicomechanical tests

Chemical analyzes were carried out on samples taken from undisturbed samples using the p-XRF method. According to the results of the chemical analysis, Midyat stone specimens contain the most MgO (25-41%) and CaO (30-43%). The amounts of SiO_2 (0,21-0,33%), SO_3 (0,13-0,17%) and Fe_2O_3 (0,065-0,21%) are almost similar in all samples. The M1 code contains slightly more MgO and CaO than the others. When evaluated in general, it is seen that the samples are similar to each other in terms of element contents.

In this study, experiments were carried out on samples prepared in accordance with TS 699 and ISRM (1981) standards. Some physical and mechanical properties of the samples are summarized in Table 1. Experiments were carried out on dry and saturated samples. In the surface hardness measurements, three measurements were taken from the same point and the third measurement was taken into account.

Table 1. Some physico-mechanical properties of specimens (After Işık et al.,2014)

S.code	ρ_g (g/cm^3)		P (%)	W (%)	d		σ_c (MPa)		I_{d2} (%)
	Dry	Sat.			Dry	Sat.	Dry	Sat.	
MD1	1.484	1.750	26.579	17.906	32.72	25.20	9.48	5.84	95.47
MD2	1.567	1.783	21.569	13.839	27.73	21.80	10.09	8.40	96.08
MD3	1.696	1.867	17.156	10.141	28.82	28.00	18.12	15.12	98.38
MD4	1.580	1.800	21.958	13.898	27.90	24.70	12.88	10.77	96.26
MD5	1.688	1.912	22.443	13.353	28.36	23.80	12.37	8.83	96.31
MD6	1.744	1.970	22.686	13.014	32.36	29.00	17.67	14.0	96.23

ρ_{g}: Density, P: Porosity, σ_c: Uniaxial compressive strength, I_{d2}: Slake durability index, W: Water absorption by weight, d: Schmidt hardness

3.2 Salt weathering test

Salt crystallization standard tests generally consist of three cycles, immersion, drying and cooling. Among these standards are small differences in terms such as temperature, sample size, time and salt concentration in each cycle. In this study, experiments were carried out in accordance with TS EN 12370 and UNE EN 12370 standards. In this experiment, the sample was dried to constant mass, then immersed in sodium sulfate (Na_2SO_4) solution, then dried and allowed to cool to room temperature. This process was repeated 15 times and the change in mass was calculated as a percentage weight loss. The equation used in calculations is given below;

$$DWL = \frac{M_w - M_{uw}}{M_{uw}} * 100 \qquad (1)$$

Where, ΔM: Percentage of dry weight loss

M_w: Dry weight of weathered specimens

M_{uw}: Dry weight of unweathered specimens

The degradation experiments based on the salt effect were carried out on three specimens prepared from the indicated rock types.

The percentage values of the amount of salt that the samples received during 15 cycles and post-wash values are graphically shown in Figure 4. Because they have similar physical and petrographic characteristics as shown in Figure 4, they exhibit similar behavior in terms of the amount of salt they acquire. Generally, after the sixth and twelfth cycles, decay is beginning to occur in the samples.

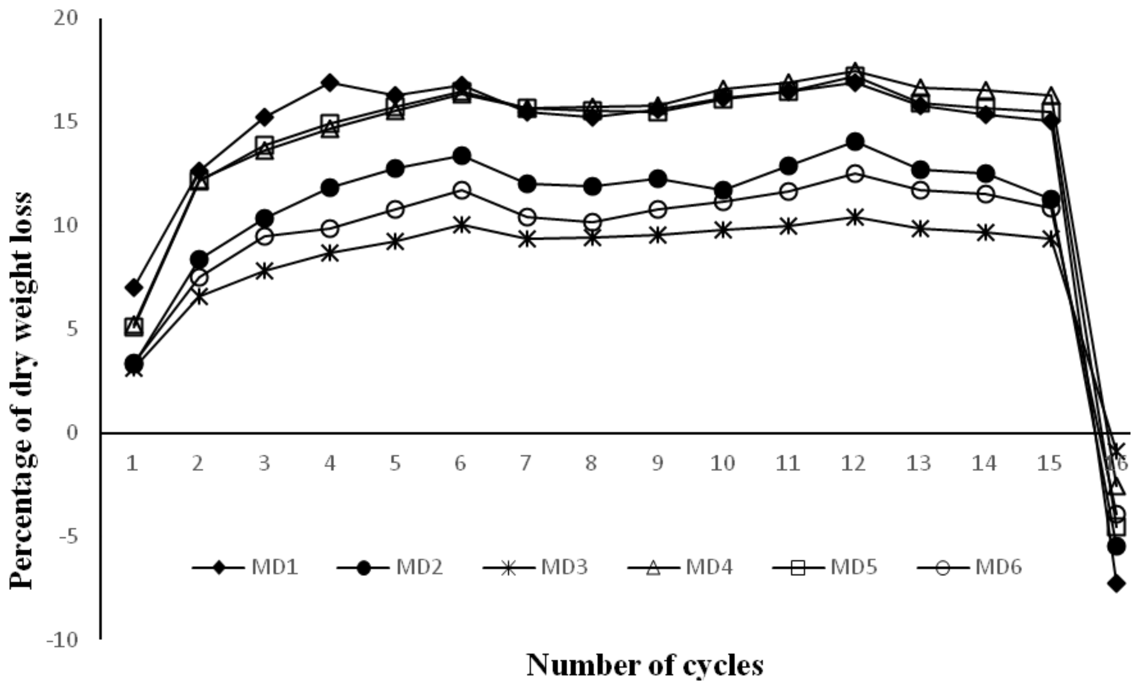

Figure. 4. The temporal pattern of the percentage weight change of the six stone types over 15 cycles

4. RESULTS AND DISCUSSION

The dry weight loss approach is used in the disintegration studies due to salt crystallization. The calculation results are presented in Table 2.

Table 2. Dry weight loss values of specimens

Specimens code	Dry weight (gr)		Dry weight loss (%)
	unweathered	weathered	
MD1	500.0200	463.7733	-7.24904
MD2	320.4700	302.8500	-5.49817
MD3	612.3900	606.9133	-0.89431
MD4	364.7333	355.4033	-2.55803
MD5	367.7467	350.9667	-4.56292
MD6	396.8833	381.2167	-3.94742

The degradation due to salt crystallization has a strong connection with the characteristics of the rock as mentioned before. For example, the salt effect is much lower in magmatic (except volcanic rocks) and metamorphic rocks and is apparent in sedimentary rocks (Unal et al., 2006). After the dry weight loss test, no disintegration was observed in the specimens. Degradation occurred at the surface of the specimen, especially at the corners (Figure 5).

Figure 5. Degraded specimens after salt crystallization experiments

It is known that salt crystallization is an important effect on porous structures. Dry weight loss is higher in specimens with high porosity. As shown in Figure 6, there is a high correlation between dry weight loss and porosity and water absorption by weight. It is evident that studies (Unal et al., 2006; Unal and Gundoğdu, 2011) using different originated rocks, where porosity is not the only determinant, are evident. However, it has been determined that porosity can be used as a decisive factor for the Midyat limestones.

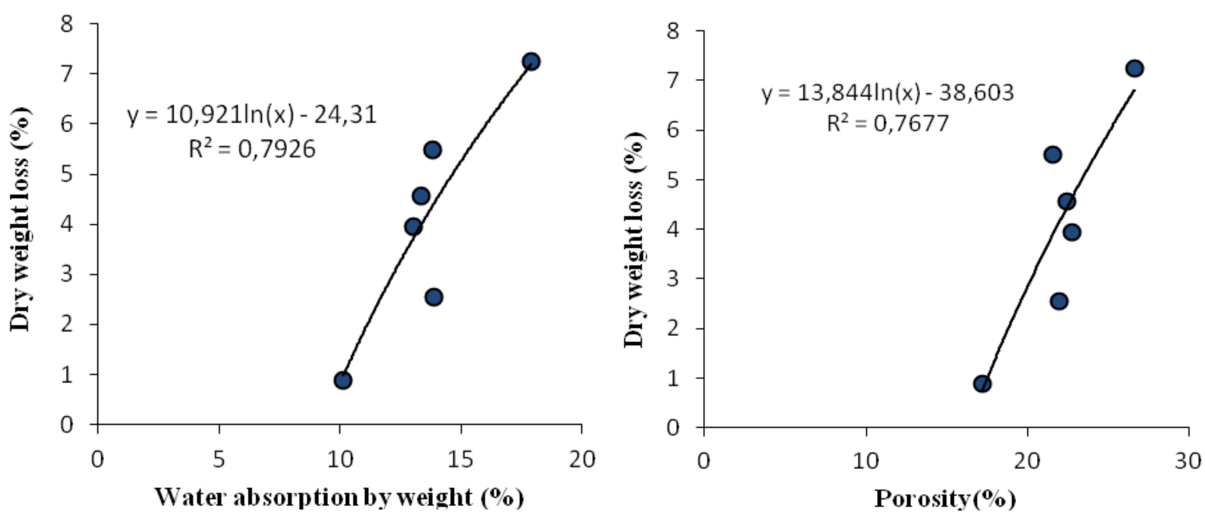

Figure 6. Variation of dry weight loss due to porosity and water absorption by weight

In addition, high correlations between hardness and density ratios of the samples and dry weight loss were found (Figure 7). This result shows that the saturated/dry proportion can be used to describe the degradation of rocks.

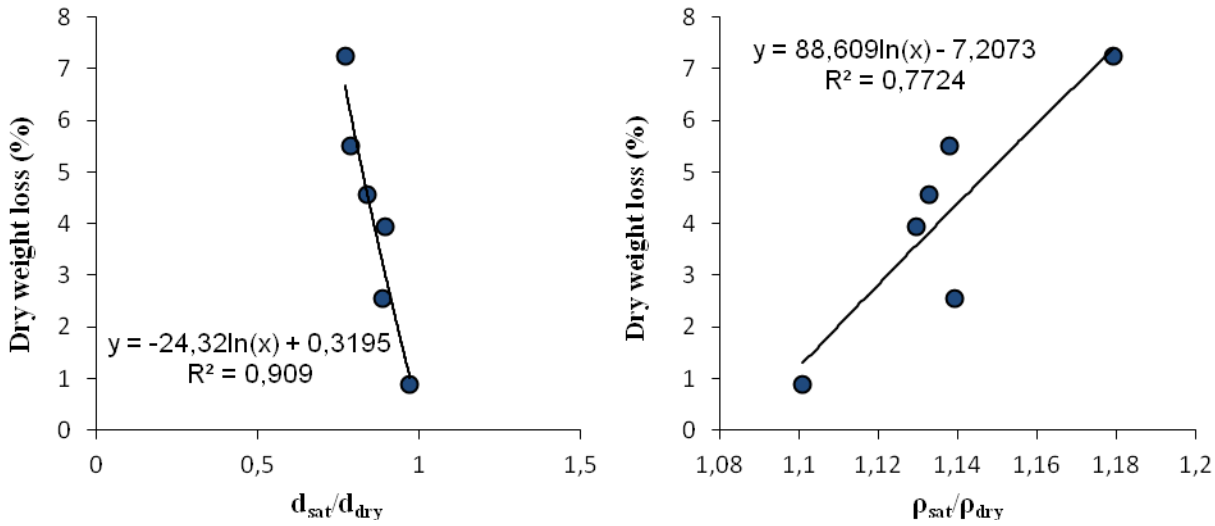

Figure 7. Variation of dry weight loss due to surface hardness and density proportions

5.CONCLUSIONS

The resistance to salt crystallization of samples taken from different quarries of Midyat limestones was investigated by means of the dry weight loss experiment and a variation of about 1-7% degradation was observed. A highly correlated relationship between the resistance of the specimens to salt and water absorption and porosity by weight was determined. Therefore, it has been determined that the porosity and water absorption properties of Midyat building stone with widespread use are an important parameter in the selection of the usage areas, especially in the selection of building stone used in doors, windows, columns, and arches.

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