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Detection of materials and material deterioration in historical buildings by spectroscopic and petrographic methods: The example of Mardin Tamir Evi

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Abstract

The province of Mardin is an area where stone material is concentrated in terms of its geographical region, and it is a city that is under protection as a protected area with its historical buildings made of local Mardin stone extracted from the region. However, in the historical city of Mardin, as in the rest of the world, stone structures are subject to deterioration due to various effects and protection interventions are often needed in the region. The lack of information on the compatibility of materials used in the past years in Mardin, as in many other countries, has caused serious damage to historical textures and structures in many cases. Today, integrated studies of the analysis of available materials and the selection of restoration materials are often included in the restoration programs of monuments. The aim of this study is to document the characteristics of the local Mardin stone, the material problems it is exposed to, through stone material and mortar samples taken from a historical residence in Mardin, and thus to contribute to the selection of compatible restoration materials for the sustainable management of the structures in the geographical region. In this context, an examination was made on the materials and mortar samples used in the building, which constitutes a representative sample from the building. Analysis of proteins, fats and water-soluble salts with simple spot tests on samples defined by visual analysis and their conductivity, the amount of CaCO3 with the loss of 105 °C and 550 °C by calcination analysis, the content and problems of the samples were investigated by determining the general texture and mineral content by stereo microscope and petrography analysis, and the quality and proportions of the aggregates of the acid-treated sample with stereomicroscope analysis. The results of this study are important in terms of creating a guideline for the use of compatible materials in the restoration stages in structures made with local Mardin stone in Mardin. Based on the analysis results obtained in the study, it is hoped that correct applications will be made in the selection of materials in the restoration applications to be made in the geographical region.

1. Introduction

Historical buildings deteriorate due to traditional building materials (stone, brick, air or hydraulic mortars, etc.), certain environmental loads and unsuitable materials (cement, polymeric materials, etc.) used in previous restoration interventions, and various restoration interventions are needed on the structures. In the restoration materials used in the interventions, the original materials used in the building should be taken into consideration, and in order to choose a compatible restoration material, the physical, chemical and mechanical behavior of the repair material should be compared with the original ones. In order to make this comparison, before proceeding to the repair phase in historical buildings, first of all, the properties of the materials should be determined in detail on the mortar and material samples, which form a representative sample from the monument [1,2]. Restoration

materials to be used for historical buildings and monuments are a frequently discussed topic in the repair phase of buildings in the world [3]. Today, integrated studies of the analysis of existing mortars and the design of restoration mortars are often included in the restoration programs of monuments [4,5]. The purpose of the analysis of historical materials is to obtain information about the physical and chemical composition of the materials as well as the production technology [6]. However, after this accumulation of knowledge, a detailed study on the synthesis of compatible mortars and materials in order to proceed with the restoration of the historical structure can lead to correct results in conservation applications [7].

Recently, scientific conservation studies have been carried out to clarify the deterioration factors by non-destructive diagnosis on the samples taken from the building based on the characteristics of the stones that make up it, in order to establish a systematic approach to the preservation of stone cultural heritage [8-12]. Petrographic and spectroscopic analyzes have proven useful in several studies to establish a guideline for the use of compatible materials in the restoration phase [13]. Patil et al [14] carried out microscopic studies such as petrographic and Scanning Electron Microscopy (SEM), Energy Dispersive X-ray spectroscopy (EDS) calculation for detailed characterization of stone degradation in Kopeshwar Temple and Panhala fort and found that these studies provided sufficient information about the nature and distribution of the mineralogical phases and elements within the basalt stone sample and the stone interface, which contributed to the identification of essential minerals and the behavior responsible for stone degradation. Columbu et al [15] used petrographic and mineralogical analyzes of stone materials to describe the chemical composition of rocks and to examine the surface properties of the stone and found these methods to be useful for identifying possible old treatments used to identify and maintain surface alteration processes. Campos-Suñol et al. [16] used Optical microscopy, scanning electron microscopy-energy dispersive x-ray spectrometry (SEM-EDX), x-ray diffraction, Raman spectroscopy, and infrared spectroscopy for the microstructural and compositional analysis of the dark yellow patinas seen on the substrate of the stone in the historical monuments of Úbeda and Baeza (Spain), and detected the types of deterioration on the patinas with these methods. Colao et al. [17] used laser-induced failure spectroscopy and found that spectroscopy measurements were a fast and effective method for detecting material deterioration. Theologitis et al. [18] analyzed the mortar and plaster samples taken from the Frangokastello Castle in Sfakia (Western Crete) and showed that the mechanical behavior of the restoration mortar can be compared with the historical ones. The data obtained as a result of the analysis of the materials in the building showed that they formed a laboratory guideline for the composition of the restoration material. It is stated that such applications have not yet been created on a regional scale in many countries, especially in Crete, and that these analysis catalogs should be created on the basis of geographical region in different countries.

In this study, it is requested to create a stone analysis catalog to be used in the restoration of stone structures in Mardin province, based on the necessity of creating the stone analysis catalogs specified in the literature on the basis of geographical region in different countries. The aim of the study in this context is to document the characteristics of the local Mardin stone and the material problems it is exposed to, through the stone material and mortar samples taken from a historical residence in Mardin, and thus to contribute to the selection of compatible restoration materials for the sustainable management of the structures in the geographical region.

The lack of information on the compatibility of mortars and raw materials in the historical stone structures of the city of Mardin, as in many countries, in many cases caused serious damage to the historical texture and structures. Mardin Tamir Evi, located in the city of Mardin, which is the subject of the study, is a masonry structure built of local Mardin stone, which has all the features of Mardin traditional houses selected within the scope of the Mardin House Conservation and Repair Project. In recent years, it is seen that the signs of deterioration in the structure have accelerated. Accurate identification of weathering forms and intensity is an important factor in determining conservation methods. In the case study of a traditional house, which is a stone historical building, in the Southeastern Anatolia region, stone material samples were analyzed and restoration materials compatible with the existing substrate were investigated. Petrographic and spectroscopic studies were performed for detailed characterization of stone degradation on stone samples collected from the study area to better understand the composition and formation of degradation products, and to identify contaminants and to evaluate their effects on limestone. These studies provided information about the local Mardin stone sample and the nature and distribution of the elements, the nature and distribution of the mineralogy phases within the stone interface, and the material degradation, which contributed to the identification of basic minerals and the behavior responsible for stone degradation. Microstructural analysis reveals that the degradation process has already begun inside the building blocks.

2. Material and Method

Within the scope of the "Mardin House Conservation and Restoration Project" carried out by the Cultural Heritage Preservation Association and the Mardin Archeology Museum, 3 wood samples, 12 stone samples, and from the deep between knitting stones12 mortar samples, were taken from the Mardin House from a building in the Artuklu District of Mardin Province. The following analyzes were carried out in the Restoration-Conservation and Analysis Laboratory of the Mardin Museum.

Table 1. Stone samples

Sample No	Explanation
1-Z01 (Stone)	It is a solid example of a yellowish light brown colored stone with black deposited dirt on its surface, taken from the damaged part of the vault of the semi-open courtyard section of the house.
2-Z01 Ton. (Mortar)	It is a sample of brownish gray mortar, with white masses up to 4 mm in size, at least 4-8 mm in size, taken from among the masonry stones in the damaged part of the vault of the semi-open courtyard section of the house, which disintegrates while it is intact.
3-Z01 D.D. (Mortar)	It is a relatively solid sample of brownish gray mortar with white masses up to 2 mm in size, 3-5 mm in spatter, and taken from the wall of the semi-open courtyard section of the house.
4-Z02 K.C.D. (Mortar)	It is a sample of brown-colored mortar containing aggregates up to 10 mm in size, relatively solid in place, and dispersed when taken, taken from the south exterior (courtyard) façade of the house.
5-Z02 A.K.C. (Stone)	It is a very solid example of a yellowish-brown stone with a layer of black dirt on its surface, taken from the upper part of the niche of the well, located in the semi-open courtyard of the house.
6-Z02 A.K.C. (Mortar)	The south exterior (courtyard) façade of the house is a solid example of cream-colored mortar with aggregates up to 12 mm in size, taken from among the brickwork of the eastern window.
7-Z03 T.T.Y.T. (Stone)	It is an example of a solid yellowish-white stone, taken from the vault of the upper floor entrance room of the house, from the blooming (salting) area.
8-Z03 G.D. (Mortar)	The south wall of the upper floor entrance room of the house is a solid example of cream-colored, solid mortar with a small amount of aggregates up to 4 mm, taken from the wall between the windows and between the brickwork.
9-Z03 T.T.Y. (Stone)	The upper floor entrance room of the house is a solid example of light cream colored stone with yellow spots on the surface, taken from the flowering part of the beginning of the vault in the north.
10-Z03 B.D.D. (Mortar)	It is a relatively weak sample of brown-colored mortar, which was taken from the masonry of the west wall of the entrance room and the west wall of the house, containing aggregates up to 10 mm in size.
11-Z03 Y.D. (Stone)	It is a sample of solid, non-porous, cream-colored stone with yellow spots on the surface, taken from the ground floor of the house, entrance room floor.
12-Z04 T.D. (Mortar)	It is a weak mortar sample taken from the vault that forms the ceiling of the second room of the house, dark brown in color, the aggregates of which cannot be seen, but white masses up to 3 mm in size and a small amount of ceramic pieces between 5-10 mm in size can be seen.
13-Z04 T.K. (Stone)	It is an example of a very solid, non-porous colored stone with a yellowish light brown color, with brown deposits on the surface, taken from the arch of the vault that forms the ceiling of the ground floor and the second room of the house.
14-Z04 D.D. (Mortar)	It is a light gray colored mortar sample taken from the east wall of the ground floor, second room of the house, with white particles up to 4 mm in size and yellowish brown deposits on the surface.
15-Z05 Yüz. (Stone)	It is an example of a yellowish-cream colored, heavily fractured and cracked stone with dark yellow stained areas on the surface, taken from the middle part of the vault of the entrance floor, second room of the house.
16-102 T.T.O. (Stone)	It is a solid example of yellowish-cream colored stone with visible cracks and cracks, with a black colored dirt layer on the surface, taken from the vault of the second room of the house, from the surface of the place where the salinization occurs.
17-102 D.D.Y. (Stone)	The upper floor façade of the house is a solid example of a light brownish-cream colored stone with eroded surface and yellow stained areas from place to place, taken from its outer surface.
18-102 T.D. (Mortar)	It is a light gray and white colored solid mortar sample that has no aggregate but has a 6 mm white mass taken from the vault of the upper floor entrance room of the house.
19-102 G.D.Y. (Stone)	This is a solid example of a brownish yellow stone with algae formation on the surface, soot and accumulation pollution and a small amount of erosion, taken from the south wall of the upper floor entrance room of the house, under the skylight.
20-102 G.D.B. (Stone)	It is a solid stone sample taken from the south wall of the upper floor entrance room of the house, between the door and the window, in a brownish-cream color, with white areas up to 4 mm in size, with abundant flowering and a small amount of erosion on the surface.
21-102 B.D.D. (Mortar)	It is a brownish gray mortar sample taken from the west wall of the upper floor entrance room of the house, with aggregates up to 6 mm in size, solid in place, and dispersed while taking it.
22-102 G.D. (Stone)	It is a solid example of a light brownish-cream colored stone with creamy-white particles up to 5 mm in size and yellow deposited pollution on the surface, taken from the south wall of the upper floor entrance room of the house, over the window in the direction of the door.
23-103 B.D. (Mortar)	It is a sample of cream gray colored mortar, containing cream-white particles up to 2 mm in size, solid in place and disintegrating when taken, taken from the west wall of the upper floor entrance room of the house.
24-103 B.D.D. (Mortar)	It is a sample of brownish gray mortar, containing cream-white aggregates up to 6 mm in size, solid in place and disintegrating when taken, taken from the west wall of the upper floor entrance room of the house.
25 (Wood)	The lower floor of the house is a wood sample taken from the beams on the entrance door, with light yellow, dark colored rots, drying cracks and insect flight holes visible.
26 (Wood)	The lower floor of the house is a wood sample taken from the beam on the window, with yellow, dark rot and insect flight holes visible.
27 (Wood)	The upper floor of the house is a wood sample taken from the beams on the kitchen door, where light brown, dark rots, drying cracks and insect flight holes can be seen.


Sample-1


Sample-2


Sample-3


Sample-4


Sample-5


Sample-6


Sample-7


Sample-8


Sample-9


Sample-10


Sample-11


Sample-12

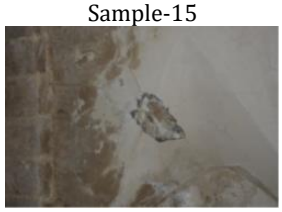

Sample-13


Sample-14


Sample-15


Sample-16


Sample-17

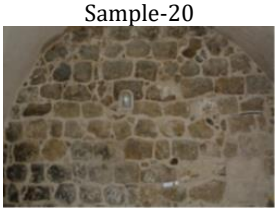

Sample-18


Sample-19


Sample-20


Sample-21


Sample-22


Sample-23


Sample-24


Sample-25


Sample-26


Sample-27

Figure 1. Samples taken from Tamir Evi

In this study, the content and problems of the samples whose definitions were made by the visual analysis were investigated. Conductivity was investigated with analysis of protein, oil, and water-soluble salts with simple spot tests, $CaCO_3$ amount was investigated with 105 C and 550 C loss with calcination analysis, general texture, and mineral content were investigated with a stereo microscope and petrography analysis, and quality and proportions of the acid-treated aggregates were investigated with stereo microscope analysis. In addition, as a result of examining the macroscopic properties of wood samples, the problems of wood were investigated, and by examining the transverse radial and tangential sections prepared from these samples under the microscope, the types of wood were investigated.

2.1. Protein and Fat Analysis with Water-Soluble Salts

Analyzes of simple spot tests were made to be able to determine the qualities of the water-soluble salts (chlorine ($C\ell$-), sulfate (SO_4=), carbonate (CO_3=) and nitrate (NO_3-) salts), and their amounts, and to decide whether the addition of additives such as saponifiable oil and protein or not into the samples and the results are given in Table 1.

Table 1. Protein and Fat Analysis of Samples using Water-Soluble Salts

Sample	Cl^-	SO_4^{-2}	CO_3^{-2}	NO_3^-	Conductivity (µs)	Salt (%)	Ph	Protein	Oil
1	+	-	-	-	267	1.46	7.36	-	-
2	+	-	-	-	662	3.70	7.87	+	-
3	++	-	-	+++	1227	6.88	7.68	+	-
4	+	-	-	-	325	1.82	7.67	+	-
5	+	-	-	-	241	1.34	7.47	-	-
6	++++	±	-	++++	2863	16.03	7.50	-	-
7	+	-	-	+	507	2.83	7.89	-	-
8	++++	±	-	++++	2284	12.80	7.74	-	-
9	+	±	-	++	997	5.59	7.80	-	-
10	++++	-	-	++	1740	9.74	7.98	-	-
11	+++	-	-	±	556	3.11	7.79	-	-
12	++	-	-	-	345	1.93	8.04	+	-
13	+	-	-	-	273	1.52	7.83	-	-
14	++++	±	-	++	1540	8.62	7.43	-	-
15	++++	±	-	++	1586	8.89	7.65	-	-
16	++	-	-	±	419	2.34	7.88	-	-
17	++++	-	-	±	1122	6.29	7.84	-	-
18	++++	±	-	+	1000	5.60	8.32	+	-
19	++	-	-	-	427	2.40	8.08	+	-
20	++++	±	-	±	1336	7.49	7.91	-	-
21	+	-	-	-	724	4.05	8.38	+	-
22	+	-	-	-	259	1.45	8.34	-	-
23	++++	±	-	++	2193	12.29	7.66	-	-
24	++++	-	-	++++	3047	17.06	8.13	-	-

-: Absent ±: Present/Absent +: Few ++: Little +++: A lot of ++++: Many

2.2. Loss of Ignition, Acid Treatment and Sieve Analysis

The calcination (heat loss) analysis results of the samples at 105 ± 5°C, 550 ± 5°C and 1050 ± 5°C, as well as the proportion of silicate aggregates that did not react and remained intact as a result of acid treatment, and the size distributions of these aggregates are given in Table 2.

2.3. Visual Analysis of Aggregates with a Stereo Microscope

The silicate aggregates of the samples, whose binders were destroyed by treatment with acid, were examined under a stereo microscope after sieve analysis and their visible properties are given in this part. In the definitions, the terms "very little" for less than 1% and "little" for 1-2% are used.

2.3.1. Sample 1-Z01(Stone)

5-10% of the 31.73% residue remaining after acid treatment of the sample is cream and brown colored, silt and clay, and the remaining part is unreacted calcarenite masses.

Table 2. Loss on Ignition and sieve analyzes of aggregates (*: Not applied)

#	Loss on ignition			Acid (%)		Retained material on sieve (%)								
	Moisture	550 C°	$CaCO_3$	Loss	Residual	6300	4000	2500	1000	500	250	125	63	<63
1	0.05	0.44	98.59	68.27	31.73	*	*	*	*	*	*	*	*	*
2	1.61	8.88	71.27	90.37	9.63	0.00	0.00	0.00	2.29	3.82	5.34	38.17	38.93	11.45
3	3.11	6.34	75.11	84.01	15.99	0.00	2.09	0.19	3.98	6.07	24.10	42.69	19.92	0.95
4	14.02	3.13	78.84	51.24	48.76	68.20	3.40	1.33	4.37	4.37	4.61	9.47	4.25	0.00
5	0.35	0.54	93.46	89.87	10.13	*	*	*	*	*	*	*	*	*
6	9.87	7.46	83.80	76.39	23.61	54.88	3.55	0.55	0.67	2.99	9.42	18.63	7.76	1.55
7	1.00	2.71	101.10	97.06	2.94	*	*	*	*	*	*	*	*	*
8	11.01	7.66	82.53	80.48	19.52	0.00	0.00	0.00	3.74	21.76	17.36	47.03	9.23	0.88
9	1.93	2.13	94.88	98.11	1.89	*	*	*	*	*	*	*	*	*
10	7.48	3.35	82.54	75.75	24.25	53.74	10.10	1.21	0.40	1.41	5.05	16.16	10.30	1.62
11	2.09	1.28	98.40	97.71	2.29	*	*	*	*	*	*	*	*	*
12	20.76	2.02	76.20	88.20	11.80	0.00	0.00	0.00	0.00	0.00	52.20	46.44	1.36	0.00
13	0.26	0.21	98.50	96.47	3.53	*	*	*	*	*	*	*	*	*
14	10.00	3.07	86.50	88.87	11.13	0.00	0.00	0.00	0.41	5.33	20.90	36.07	26.23	11.07
15	16.47	2.84	73.19	74.58	25.42	*	*	*	*	*	*	*	*	*
16	0.92	0.89	91.83	98.69	1.31	*	*	*	*	*	*	*	*	*
17	2.87	2.16	98.82	98.54	1.46	*	*	*	*	*	*	*	*	*
18	0.91	4.24	91.92	97.41	2.59	0.00	0.00	0.00	0.00	15.63	25.56	31.25	23.44	3.13
19	0.14	1.65	99.00	99.28	0.72	*	*	*	*	*	*	*	*	*
20	2.44	1.63	99.92	98.98	1.02	*	*	*	*	*	*	*	*	*
21	1.02	3.16	65.40	87.34	12.66	0.00	3.19	0.35	3.90	4.61	17.38	46.45	18.09	6.03
22	0.12	0.94	99.25	76.85	23.15	*	*	*	*	*	*	*	*	*
23	7.41	2.87	93.55	95.04	4.96	0.00	*	0.00	5.60	7.20	13.60	51.20	19.20	3.20
24	8.24	6.79	81.56	88.92	11.08	0.00	0.00	0.00	0.81	6.85	12.90	45.56	28.63	5.24

2.3.2. Sample 2-Z01 Tons (Mortar)

The remaining aggregates smaller than 125µ of the sample after acid are only brick dust feldspar and muscovite, few are black slag particles, and the rest are gray colored portland cement feldspar.

Of the 125–1000 µ sized particles, few brick fragments and muscovite, very few black slag particles, 3-5% volcanic rock particles, 10-15% quartz, the remainder are gray colored Portland cement feldspar mass.

The small amount of coarse aggregates (greater than 1000 µm in size) up to 2 mm in size, only a few brick fragments, very few black slag particles, 5-10% volcanic rock particles, 25-30% gray Portland cement is feldspar mass, the remainder is quartz.

Aggregates of the sample remaining in the acid, 1 mm under sieve size, a single shard of brick and muscovite, very little black slag particles, 3-5% volcanic rock particles, 10-15% quartz, the rest gray portland cement feldspar and is its mass.

2.3.3. Sample 3-Z01 D.D. (Mortar)

The remaining aggregates smaller than 125µ of the sample after acid are only brick dust feldspar and muscovite, few are black slag particles, 15-20% are ash, the remainder are gray colored portland cement feldspar.

Of the 125–1000 µ sized particles, very few brick fragments and muscovite, very few black slag particles, 5-10% volcanic rock particles and quartz, the remainder are ash and gray colored Portland cement feldspar mass.

Of the coarse aggregates, 1 of which is 5 mm in size and generally up to 2 mm in size, a single piece of brick is broken, very little is black slag particles, 20-25% is volcanic rock particles and quartz, the rest is ash and gray colored portland cement feldspar mass.

1 of the aggregates remaining in the acid is 5 mm in size, generally in 2 mm under sieve size, only a few brick fragments and muscovite, very little black slag particles, 5-10% volcanic rock particles and quartz, 15-20% ash, the remainder is a gray colored Portland cement feldspar and mass.

2.3.4. Sample 4-Z02 K.C.D. (Mortar)

3-5% of aggregates smaller than 125µ remaining after acid are black slag particles, the rest is brown silt and clay.

Few of the 125–1000 µ sized particles are brick fragments, 3-5% are black slag particles, the remainder is brown clay and silt mass.

The coarse aggregates, generally up to 10 mm in size, consist of very few brick fragments, very few black slag particles, some volcanic rock particles and quartz, and the rest unreacted limestone particles.

Aggregates remaining in the acid, with a size of 10 mm under a sieve, very few brick fragments, some volcanic rock particles and quartz, 3-5% black slag particles, 10-15% brown clay and silt, the rest is unreacted. limestone particles.

2.3.5. Sample 5-Z02 A.K.C. (Stone)

After the acid treatment of the sample, 10-15% of the remaining 10,13% residue is brownish yellow, silt and clay, and the remaining part is unreacted calcarenite masses.

2.3.6. Sample 6-Z02 A.K.C.(Mortar)

Few of the aggregates smaller than 125µ remaining after acid are black slag particles and brick dust feldspar, the rest is light brown silt and clay.

Of the 125–1000 µ sized particles, very few are black slag particles, few are brick fragments, 3-5% are volcanic rock particles and quartz, and the remainder are dark brown clay and silt masses.

The coarse aggregates, generally up to 12 mm in size, consist of very few brick fragments, very few black slag particles, some volcanic rock particles and quartz, and the rest unreacted limestone particles.

Aggregates of the sample remaining in the acid are 12 mm under sieve size, very few brick fragments, very few black slag particles, few volcanic rock particles and quartz, 5-10% brown clay and silt and masses, the rest unreacted limestone particles.

2.3.7. Sample 7-Z03 T.T.Y.T. (Stone)

The remaining 2.94% residue after the acid treatment of the sample is dark brown colored silt and clay and a black oil-like gel-like substance.

2.3.8. Sample 8-Z03 G.D. (Mortar)

Few of the aggregates smaller than 125µ remaining in the sample after acid are black slag particles and brick dust feldspar, the rest is dark brown silt and clay.

Of the 125–1000 µ-sized particles, very few are black slag particles, few are brick fragments, 2-3% are volcanic rock particles and quartz, and the remainder are dark brown clay and silt masses.

A small amount of coarse aggregates, very few of which are 2-4 mm in size and generally up to 2 mm in size, consist of only brick fragments, very few black slag particles, few volcanic rock particles and quartz, and the rest are unreacted limestone particles.

Aggregates of the sample remaining in the acid are 1-4 mm, generally 1 mm under sieve size, very few brick fragments, very few black slag particles, few volcanic rock particles and quartz, 10-15% brown clay and silt and their masses, the remainder are unreacted limestone particles.

2.3.9. Sample 9-Z03 T.T.Y. (Stone)

1.89% residue of the sample after acid treatment is cream-brown colored silt and clay.

2.3.10. Sample 10-Z03 B.D.D. (Mortar)

2-3% of the small sized aggregates of the sample after acid are black slag particles, the rest is brown silt and clay.

Of the 125–1000 µ sized particles, very few are brick fragments, few are black slag particles and quartz, and the rest are brown clay and silt masses.

The coarse aggregates, generally up to 8 mm in size, consist of only a few brick fragments, very few black slag particles, some volcanic rock particles and quartz, and the rest unreacted limestone particles.

Aggregates of the sample remaining in the acid are generally 8 mm under sieve size, very few brick fragments, some black slag particles, volcanic rock particles and quartz, 30-35% brown clay and silt and masses, the rest unreacted limestone particles.

2.3.11. Sample 11-Z03 Y.D. (Stone)

After the acid treatment of the sample, the residue of 2.29% is brown silt and clay and a black oil-like gel-like substance.

2.3.12. Sample 12-Z04 T.D. (Mortar)

The aggregates of the sample with a size less than 500 µ remaining after acid are black slag particles and brick dust feldspar, the rest is dark brown colored silt and clay. Brick pebbles visible in the raw sample were not included in the acid-treated part.

2.3.13. Sample 13-Z04 T.K. (Stone)

After the acid treatment of the sample, the residue of 3,53% is brown colored silt and clay and a black oil-like gel-like substance.

2.3.14. Sample 14-Z04 D.D. (Mortar)

2-3% of the small sized aggregates of the sample after acid are black slag particles, the rest is brownish gray colored portland cement feldspar.

Few of the 125–1000 µ sized particles are black slag particles, 25-30% are brownish gray colored portland cement feldspar mass, the remainder are volcanic rock particles and quartz.

Few of the coarse aggregates, which are insignificant and 1-2 mm in size, are black slag particles, 20-25% are brownish gray colored portland cement feldspar mass, the remainder are volcanic rock particles and quartz.

Aggregates of the sample remaining in the acid are generally 1 mm under sieve size, some of them are black slag particles, 25-30% are volcanic rock particles and quartz, and the rest is portland cement.

2.3.15. Sample 15-Z05 Yüz. (Stone)

After the acid treatment of the sample, 10-15% of the remaining 25.42% residue is cream yellow colored silt and clay, and the remaining part is unreacted calcarenite masses.

2.3.16. Sample 16-102 T.T.O.(Stone)

The 1.31% residue remaining after the acid treatment of the sample is dark gray and white colored silt and clay and a small amount of black oil-like gel-like substance.

2.3.17. Sample 17-102 D.D.Y. (STONE)

The 1.46% residue remaining after the acid treatment of the sample is cream colored and white colored silt and clay and a small amount of black oil-like gel-like substance.

2.3.18. Sample 18-102 T.D.(Mortar)

Most of the aggregates of the sample with a size less than 500 µ remaining after the acid are brick dust feldspar, some are quartz, 2-3% are black slag particles and the remainder are dark brown colored silt and clay.

2.3.19. Sample 19-102 G.D.Y. (Stone)

The 0.72% residue remaining after the acid treatment of the sample is cream and white colored silt and clay and a small amount of black oil-like gel-like substance.

2.3.20. Sample 20-102 G.D.B.(Stone)

The remaining 1.02% residue after the acid treatment of the sample is cream and white colored silt and clay and a small amount of black oil-like gel-like substance.

2.3.21. Sample 21-102 B.D.D.(Mortar)

3-5% of the small sized aggregates of the sample after acid are black slag particles, the rest is dark gray colored portland cement feldspar.

Of the 125–1000 µ size particles, 3-5% are black slag particles, 5-10% are volcanic rock particles and quartz, and the rest is dark gray portland cement feldspar.

The small amount of coarse aggregates, which are generally 4 mm in size, consist of black slag particles, 20-25% brown clay and silt and their masses, the rest is volcanic rock particles and quartz.

Aggregates of the sample remaining in the acid are less than 1-4 mm in size, generally 1 mm in size under a sieve, 3-5% of black slag particles, 20-25% of brown clay and silt masses and volcanic rock particles and quartz, the rest is dark gray. colored portland cement feldspar and mass.

2.3.22. Sample 22-102 G.D. (Stone)

After the acid treatment of the sample, the remaining 23.12% residue is colored with a small amount of black oil-like gel material, 10-15% is creamy yellow colored silt and clay, and the remaining part is unreacted calcarenite masses.

2.3.23. Sample 23-103 B.D.(Mortar)

Few of the aggregates smaller than 125µ remaining in the sample after acid are black slag particles, the rest is cream colored feldspar.

Few of the 125–1000 µ sized particles are black slag particles, 5-10% are white colored particles, and the remainder are cream colored feldspar masses.

Few of the small amount of coarse aggregates, which are 2 mm in size, are black slag particles, 5-10% are white colored particles, and the rest are cream colored feldspar masses.

The aggregates of the sample remaining in the acid are 1-2 mm, generally 1 mm in size under a sieve, very little black slag particles, 5-10% white colored particles that have not reacted with acid, and the rest are cream colored feldspar and its masses.

2.3.24. Sample 24-103 B.D.D. (Mortar)

Less than 125µ sized aggregates of the sample remaining after acid are brick dust feldspar, 3-5% are black slag particles, the rest is dark gray colored portland cement feldspar.

Of the 125–1000 µ sized particles, very few are brick fragments, few are black slag particles and quartz, 5-10% are white colored particles, and the remainder are dark gray colored portland cement feldspar.

Of the insignificant amount of coarse aggregates, which are generally 2 mm in size, very few are black slag particles and the rest are white colored particles.

Aggregates of the sample remaining in the acid are generally 1 mm under sieve size, very few brick fragments, few black slag particles and quartz, 5-10% white colored particles, the rest is dark gray colored Portland cement feldspar and mass.

2.3.25. Sample 25

It is a wood sample and this analysis was not done.

2.3.26. Sample 26

It is a wood sample and this analysis was not done.

2.3.27. Sample 27

It is a wood sample and this analysis was not done.

2.4. Petrographic Analysis of Samples

The textural and aggregate properties of the shiny (thick) sections prepared from the mortar and plaster samples embedded in epoxy were determined by examining under a stereo microscope (single nicol) and the mineral contents and roughly ratios of thin sections were examined under a polarizing microscope (double nicol) and the results are given below. In defining the pore ratios of the samples, the terms "slight" for pores up to 5%, "moderate" for pores of 5-15%, and "abundant" for pores greater than 15% were used. In addition, the type of wood was investigated by examining the prepared transverse, radial and tangential sections of the wood samples under the microscope.

2.4.1. Sample 1-Z01(Stone)

After the acid treatment of the sample, 5-10% of the remaining 31.73% residue is cream and brown colored, silt and clay, and the remaining part is unreacted calcarenite masses.

2.4.2. Sample-2-Z01 Ton. (Mortar)

The sample, which has a binding area of 20-25% and a brownish gray color, has aggregates up to 4 mm in cross-sectional area. For example, aggregates of which few are black slag particles and brick shards and dust, 3-5% are volcanic rock particles and quartz are 1 mm under sieve, and the remaining aggregates with limestone fragments are 4 mm under sieve size. The binder phase and binder aggregate phase of the sample, which has moderate pores up to 0.5 mm in size, are good.

2.4.3. Sample 3-Z01 D.D. (Mortar)

The sample, which has a binding area of 20-25% and a brownish light gray color, has aggregates up to 5 mm in cross-sectional area. Very little part of the sample is brick shards and dust, 2-3% is black slag particles, 3-5% is volcanic rock particles and quartz aggregates are 2 mm under sieve, the rest is limestone fragments and other aggregates are 5 mm under sieve size. The sample, which has moderate pores up to 1 mm in size, has good binding phase and binding aggregate phase.

2.4.4. Sample 4-Z02 K.C.D.(Mortar)

The sample, which has a binding area of approximately 25% and a brownish-cream color, has aggregates up to 10 mm in cross-sectional area. Very little of the sample is brick fragments and dust, some black slag particles and volcanic rock particles and quartz, 5-10% graywacke particles and aggregates with 1 mm under sieve, the rest with limestone fragments is 10 mm under sieve size. The binder phase and binder aggregate phase of the sample, which has moderate pores up to 0.5 mm in size, are good.

2.4.5. Sample 5-Z02 A.K.C. (Stone)

It is known as Urfa stone, with a light brownish yellow texture, grain sizes up to 0.5 mm, abundant macrofossils, micro cracks and veins, secondary calcite crystals as well as clay fillings and dyeings, porous up to 0.5 mm in size. It is an Eocene-Oligocene aged biomicritic clastic calcarenite limestone. On the surface of the sample, there are brownish black, organic origin impurities.

2.4.6. Sample 6-Z02 A.K.C.(Mortar)

The bond area is 35-40% and the cream-colored sample has aggregates up to 12 mm in cross-sectional area. Very little of the sample is brick fragments and dust, some of it is black slag particles and volcanic rock particles and quartz, 3-5% of the aggregates with graywacke particles and dust are 2 mm under sieve and the rest of the aggregates with limestone fragments are 12 mm under sieve size. The binder phase and the binder aggregate phase of the sample, which has 3-5% of 1-3 mm in size voids and a moderate amount of pores up to 0.5 mm in size, are good.

2.4.7. Sample 7-Z03 T.T.Y.T. (Stone)

Eocene-Oligocene aged micritic, also known as Urfa stone, with a yellowish cream-colored texture and grain sizes up to 0.5 mm, with no veins visible, but clay fillings and dyes between calcite crystals, small amount and porous up to 0.1 mm. it is limestone. On the surface of the sample, there is a yellowish accumulation of pollution from place to place.

2.4.8. Sample 8- Z03 G.D. (Mortar)

The bond area is 35-40% and the cream-colored sample has aggregates up to 10 mm in cross-sectional area. Very little of the sample is brick fragments and dust, a few black slag particles and volcanic rock particles and quartz, 3-5% of graywacke particles and aggregates are 1 mm under sieve and the rest of the aggregates with limestone fragments are 4 mm under sieve size. The binder phase and binder aggregate phase of the sample, which has abundant pores up to 0.5 mm in size, are good.

2.4.9. Sample 9- Z03 T.T.Y. (Stone)

It is an Eocene-Oligocene aged micritic limestone, also known as Urfa stone, with a yellowish-cream color, grain size up to 0.5 mm, veins are not visible, but there are clay fillings and dyes between calcite crystals, and porous up to 0.1 mm in size. On the surface of the sample, there is a yellowish accumulation of pollution from place to place.

2.4.10. Sample 10- Z03 B.D.D. (Mortar)

The sample, which has a binding area of approximately 25% and a brownish-cream color, has aggregates up to 10 mm in cross-sectional area. Very little of the sample is broken brick and dust, some of it is black slag particles and volcanic rock particles and quartz, 10-15% of the aggregates with graywacke particles and dust is 8 mm under sieve, and the rest of the aggregates with limestone fragments are 10 mm under sieve size. For example, with moderate pores up to 0.5 mm in size, the binder phase and binder aggregate phase are good.

2.4.11. Sample 11-Z03 Y.D. (Stone)

It is an Eocene-Oligocene aged micritic limestone, also known as Urfa stone, with a yellowish-cream color, grain size up to 0.5 mm, veins not visible, but clay fillings and dyes between calcite crystals, small amount and porous up to 0.1 mm. On the surface of the sample, there are yellow-brown colored, stain-like, accumulated impurities on the surface.

2.4.12. Sample 12-Z04 T.D. (Mortar)

The sample, which has a binding area of 30-35% and a creamy white color, has aggregates up to 1 mm in cross-sectional area. Very little of the sample is brick fragments and dust, a few black slag particles and volcanic rock particles and quartz, 5-10% graywacke particles and dust aggregates are 0.5 mm under sieve, the rest is 1 mm under sieve size. The binder phase and binder aggregate phase of the sample, which has abundant pores up to 0.5 mm in size, are relatively weak.

2.4.13. Sample 13-Z04 T.K. (Stone)

Eocene-Oligocene aged, also known as Urfa or Mardin stone, with a yellowish-brown texture and partially recrystallized, very small and semi-euhedral grain sizes, with secondary calcite crystals and clay dyeings in the veins and around the fragments, porous up to 0.1 mm in size. It is a limestone composed of micrite sized calcites. On the surface of the sample, there is a brownish, slightly crusty accumulation of impurity.

2.4.14. Sample 14- Z04 D.D. (Mortar)

The sample, which has a binding area of 25-30% and a light gray color, has aggregates up to 4 mm in cross-sectional area. Very little of the sample is brick shards and dust and black slag particles, 3-5% of volcanic rock particles and quartz aggregates are 1 mm under sieve and the remaining aggregates with limestone fragments are 4 mm under sieve size. Binder phase and binder aggregate phase of the sample, which has abundant pores up to 0.5 mm in size, are quite good.

2.4.15. Sample 15- Z05 Yüz. (Stone)

Eocene-Oligocene, also known as Urfa or Mardin stone, with a light yellowish cream color texture, average grain size of 0.5 mm, filled with secondary calcite crystals, abundant micro-cracks and clay stains in places, porous up to 0.2 mm. It is a calc-arenite limestone consisting of aged micrite-sized calcites. On the surface of the sample, there are dark yellow brown colored and less black colored deposited crustal impurities in places.

2.4.16. Sample 16- 102 T.T.O.(Stone)

Eocene-Oligocene aged micritic limestone, also known as Urfa stone, with a yellowish-cream color, grain size up to 0.5 mm, crack-like veins and secondary calcite crystals and clay staining around the crumbs, porous up to 0.1 mm in size.

2.4.17. Sample 17-102 D.D.Y.(Stone)

Eocene-Oligocene aged micritic limestone, also known as Urfa stone, with a yellowish light brown texture and grain sizes up to 0.5 mm, with no veins visible, but clay fillings and dyes between calcite crystals, small amount and porous up to 0.1 mm.

2.4.18 Sample 18-102 T.D. (Mortar)

The sample, which has a binding area of 30-35% and a creamy white color, has aggregates up to 1 mm in cross-sectional area. Very little of the sample is broken brick and dust, volcanic rock particles and quartz and black slag

particles, aggregates with few graywacke particles and dust are 0.5 mm under sieve, while the rest of the aggregates with limestone fragments are 6 mm under sieve size. For example, the binder phase and binder aggregate phase are good, with abundant pores up to 0.5 mm in size.

2.4.19. Sample 19-102 G.D.Y. (Stone)

It is also known as Urfa stone, with a brownish yellow texture and grain sizes up to 0.5 mm, with abundant macrofossils, with no veins visible, but with clay filling and dyeing between the calcite crystals, with a small amount of pores up to 0.5 mm in size, is an Eocene-Oligocene aged biomicritic limestone. On the surface of the sample, there are yellow-brown-black colored, soot, moss and organic origin, crust-like, accumulated impurities.

2.4.20. Sample 20- 102 G.D.B. (Stone)

Eocene-Oligocene aged biomicritic limestone., also known as Urfa stone, with a brownish yellow texture and grain sizes up to 0.5 mm, with abundant macrofossils, with clay filling and dyeing between calcite crystals, with abundant macrofossils, up to 0.5 mm in size. On the surface of the sample, there are very light, brownish yellow, organic origin impurities.

2.4.21. Sample 21-102 B.D.D. (Mortar)

The aggregates in the cross-sectional area are up to 6 mm in the sample, which has a binding area of 25-30% and a creamy white color. The sample contains very little brick fragments and dust, some black slag particles, 3-5% volcanic rock particles and quartz, 5-10% graywacke particles and dust aggregates 0.5 mm under sieve, and other aggregates with limestone fragments. Is 6 mm under sieve size. The binder phase and binder aggregate phase of the sample, which has abundant pores up to 0.5 mm in size, are relatively weak.

2.4.22. Sample 22-102 G.D. (Stone)

Its texture is brownish yellow and partially recrystallized, its grain sizes are very small and semi-euhedral, it has secondary calcite crystals and clay dyeings in the veins and around the fragments, as well as abundant fossils, it is porous up to 0.5 mm in size, also known as Urfa or Mardin stone. It is calrenite limestone with biomicrite clastics, composed of Eocene-Oligocene aged micrite-sized calcites. On the surface of the sample, there is dark yellow – brown colored, organic origin, deposited crustal contamination.

2.4.23. Sample 23-103 B.D. (Mortar)

The bond area is 35-40% and the cream colored sample has aggregates up to 2 mm in cross-sectional area. Very little of the sample is broken brick and dust, some of it is black slag particles and volcanic rock particles and quartz, 3-5% of the aggregates with graywacke particles and dust is 1 mm under sieve, the rest of it is 2 mm under sieve size. The binder phase and binder aggregate phase of the sample, which has small pores up to 1 mm in size, are good.

2.4.24. Sample 24-103 B.D.D. (Mortar)

The binder area is approximately 20% and the gray colored sample has aggregates up to 6 mm in cross-sectional area. Very little of the sample is brick fragments and dust, less of it is black slag particles, 3-5% is volcanic rock particles and quartz aggregates are 1 mm under sieve, the rest is limestone fragments and other aggregates are 6 mm under sieve size. For example, the binder phase and binder aggregate phase are good, with abundant pores up to 0.5 mm in size.

2.4.25. Sample 25-Wood

It has been determined that the light yellow colored wood sample has a scattered trachelia structure in its cross-section, and gradually decreases in the number and diameter of the tracheas from the spring wood to the summer wood layer. In the radial section, the perforation tables are of simple type and sometimes as tulles has been determined. In the tangential section, it has been determined that the pith rays are single-lined, their heights are very different, and they range from 3-5 cells high to 30 cells high.

2.4.26. Sample 26-Wood

It has been determined that the yellow colored wood sample has a scattered trachelia structure in its cross-section, and gradually decreases in the number and diameter of the trachea as we go from the spring wood to the summer wood layer. In the radial section, perforation tables are seen as simple type and sometimes as tulles. In the tangential section, it has been determined that the pith rays are single-lined, their heights are very different, and they range from 3-5 cells high to 30 cells high.

2.4.27. Sample 27-Wood

It has been determined that the light brown wood sample has a ringed tracheal structure in its cross-section, the trachea in the summer wood layer are arranged in a radial and diagonal arrangement, it forms a flame-like structure, the longitudinal parenchymas are in the apotraheal scattered and tangential stripe order, and there are paratraheal parenchymas. It has been determined that the core rays are homogeneous in the radial section, the perforation tables are simple type, the meeting passages of the core rays and the trachea are large, round and oval. In the tangential section, it has been determined that the core rays are in two different widths, very wide and single cell width.

3. Results

When all these results are brought together, 12 mortar samples taken from the traditional house of Mardin selected within the scope of the "Mardin House Conservation and Repair Project" were classified into 2 main groups according to the analysis results, binders and aggregates remaining after acid treatment.

The binder of the mortar samples numbered 4, 6, 8, 10, 12, 18, 21 and 23, which is classified as the first main group, is air lime (cream lime) and is divided into 2 subgroups according to the binder lime ratios. While an average of 35% cream lime was used as binder in samples 6, 8, 12, 18, 21 and 23, which are classified as subgroup 1A, an average of 25% cream lime was used in samples no. 4 and 10, classified as subgroup 1B. While samples 8, 12 and 21 belonging to subgroup 1A, average 5mm under-sieve size limestone fragments were used as aggregate, in samples 12 and 23 2-mm under sieve size limestone fragments and in sample 6 12-mm under-sieve size limestone fragments and pebbles were used as aggregate. In samples 4 and 10 belonging to subgroup 1B, 10 mm under-sieve size limestone fragments were used as aggregate. It is thought that the graywacke particulate sands and volcanic rock particles and quartz sands, which are determined in the aggregates of almost all of the samples and which amount to 5-10% in total, are found in the source where the limestone broken sand is obtained. According to their binding nature, the mortars belonging to subgroup 1A were considered to be original, while the mortars belonging to subgroup 1B were considered to belong to the complements and/or repairs made during or after the construction process.

Mortar No. 2, 3, 14 and 24, which is classified as the second main group, is a sample binder, Portland cement with 10-15% lime added, varying between 100-200 doses, and its aggregates are 5 mm in average under sieve size and 3-5% volcanic fracture of limestone, which is rock particles and quartz. In the 3rd sample of this group, approximately 5% ash was added additionally. It has been understood that the mortars of this group, depending on their binding nature, were used in the extensive and/or individual repairs made in the middle or the second half of the 20th century. It has been visually determined that all of the plasters applied on the vaults of the house, which did not need to be taken as samples, were recent plasters with portland cement binder (Figure 1,2).

(a)

(b)

Figure 1a. In the vault of the space in the semi-open courtyard of the house
Figure 1b. Upstairs, recent repair plasters with portland cement binder in the kitchen vault

(a)

(b)

Figure 2a. Upstairs of the house, recent repair plaster with portland cement binder in the vault of the entrance room

Figure 2b. Plant formations and stains caused by water on the inner surface of the south wall

In addition, it is determined that in the construction of the house, partially clayey and/or recrystallized micritic limestones consisting of Eocene-Oligocene micrite-sized calcites, also known as Urfa or Mardin stone, whose mineralogical properties are given above, were used as masonry material, biomicritic limestones with abundant fossils, micrite or biomicrite clastic calcarenite limestones were used. It has been determined that a significant part of these stones contain a small amount of petroleum-like, non-saponifiable (mineral-based) oil.

The stones in the ground floor of the house and the rock-cut section were found to be micritic limestone with plenty of cracks, which has not yet completed its petrification, looks like greywacke and has plenty of clay. It has been determined that there are surface erosions on the inner and outer surfaces of the walls of the house, especially in the areas of water evaporation, there are chloride and nitrate salts from the repair mortars and plasters with portland cement binder in general, and from the sewage in places, from the water leaking from the walls and roof (roof) of these salts, from the flowering cycle of these salts. In addition to these surface problems, as a result of the overflow of the water tank on the roof of the house, wetting on the outer surface of the south wall of the house, accordingly the formation of herbaceous plants on the exterior, woody plant formations on the garden wall, as well as the moisture problem in the entire building has been seen. As a result of these wetting and drying cycles, there has been an increase in flowering and surface erosion of the mesh stones (Figure 3,4).

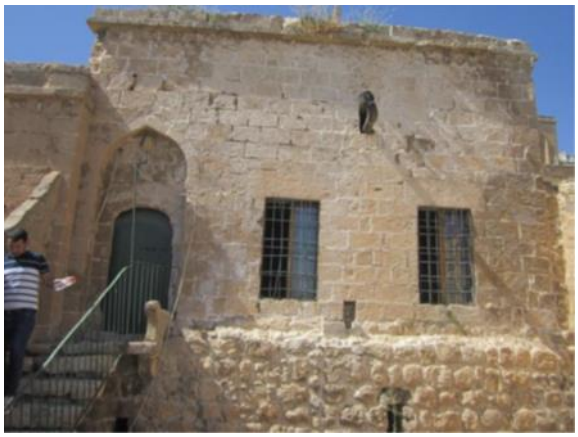
(a)

(b)

Figure 3a. On the outer wall surface of the house, with herbaceous plant formations due to wetting

Figure 3b. General views of the woody plant formation on the garden wall

(a)



(b)

Figure 4a. General view of efflorescence (salt deposits) occurring in the evaporation zone on the interior wall surfaces of the house

Figure 4b. General view of efflorescence (salt deposits) occurring in the evaporation zone on the exterior wall surfaces of the house

In addition, poplar (Papulus Nigra L.) wooden elements were used on the beams on the doors and windows on the lower floor of the house, while oak (Queras SPP.) wooden elements were used on the beams on the doors and windows of the upper floor (Figure 5).

(a)

(b)

Figure 5a. General view of the wooden elements used on the door tops and the damage caused by rot and insect infection on these wooden elements

Figure 5b. General view of the wooden elements used on the window tops and the rot and insect infection damage on these wooden elements

In addition, according to the gallery type, Anobium Punctatum (Furniture Beetle) is used on the wooden main carriers that carry the wooden elements, which are exposed to brown-colored rot in various intensities due to humidity and individual wetting in general, and which carry the connecting wall of the place between the bagdadi laths and the Z02 space of the Observatory and the connection corridor.) were found to be infected by insects, which are understood to be of the genus. In addition to the problems in the building materials of the house, it has been visually determined that there are structural static problems in the walls and rock-carved vaults of the house, although not much. In addition, it is seen that there is a very serious structural crack in the wall of the neighboring house, which is understood to have been partially destroyed and repaired before (Figure 6).

(a) (b)

Figure 6a. General view of static problems on the interior wall of the house
Figure 6b. General view of static problems on the wall of the neighboring house

4. Discussion and Conclusion

In this study, it is aimed to document the characteristics of the local Mardin stone, the material problems it is exposed to, through the stone material and mortar samples taken from a historical residence in Mardin, and thus to contribute to the selection of compatible restoration materials for the sustainable management of the structures in the geographical region. In this context, an examination was made on the materials and mortar samples used in the building, which constitutes a representative sample from the building. The results of this study are important in terms of creating a guideline for the use of compatible materials in the restoration stages in structures made with local Mardin stone in Mardin. According to the analysis results obtained in the study, it is seen that material deterioration can be detected by spectroscopic and petrographic methods. This finding obtained from the study supports the results of the study, which determined that the petrographic and spectroscopic analyzes determined in various studies in the literature are useful for creating a guideline for the use of compatible materials in the restoration phase [8-13].

Based on the analysis results obtained in the study, it is hoped that correct applications will be made in the selection of materials in the restoration applications to be made in the geographical region. According to the evaluation made by combining these results, it is necessary to eliminate the static problems seen in the walls of the house and the vaults of the rock-carved sections, or to take measures (suspension, support, etc.) against these problems. After the necessary static measures are taken, it is recommended to remove the modern Portland cement binder vault plasters, which are determined to be in the near term, by scraping, although it is the project decision whether to remove these plasters (because it has been applied throughout the vaults). If it is decided to remove the Portland cement binder vault plasters, it would be appropriate to carry out this application sensitively by mechanical method. If it is decided to preserve the Portland cement binder vault plasters (to complete the existing state without scraping), the light accumulation of dirt and salt crystals on the interior and exterior surfaces of these plasters and other walls should be removed first by using a plastic brush and vacuum cleaner, then once (It would be appropriate to continue cleaning with pulp impregnated with 5% ammonium bicarbonate solution (twice) or twice if the stain does not come off, and finally, salt cleaning should be done twice with clean (drinkable quality) water-impregnated pulp.

It would be appropriate to remove the recently made Portland cement bonded joints by scraping them with precision and mechanical method. It would be appropriate to remove the rotten and infected woods and the insect-infested wooden beams on the door and window beams, or all or all of the rotten and infected woods. It would be appropriate to complement and/or renew the partially and/or completely removed woods that have lost their function with wood of the same type (poplar on the lower floor, oak type on the upper floor), and impregnation of the new woods with a vacuum system.

In the walls and vaults of the house to be completed or newly built, cut and/or half-hewn Mardin stone as stone, it would be appropriate to use a mixture of 1 part air lime (50 ± 2% hydrated cream lime) as a binder, 0.25 part pozzolan as an additive, 2 mm as aggregate 0.5 part quartz black sand as under sieve size, 2.25 parts limestone crumb and dust (or carbonate aggregates to be obtained from sand quarries) with 10 mm under sieve size, and trowel finishing on the joints where plaster application will not be applied. In new joint applications to be made on the walls and vaults of the house, it will be appropriate to use a mixture of 1 part air lime (50 ± 2% hydrated cream lime) as binder, 0.25-part pozzolan as additive, 0.5-part quartz black sand as aggregate, 2 mm under sieve

size. of 2 parts of limestone crushed and dust (or carbonate aggregates to be obtained from sand quarries), 6 mm (or in narrow joints, not exceeding half of the joint gap) under sieve size and trowel finishing. In reinforcing the existing plasters of the house (on vaults and partially on the wall surfaces), it would be appropriate to use a mixture of 1-part hydraulic lime (NHL 3,5), 0.25-part pozzolan as additive, 0.5-part quartz black sand, 4 mm under sieve size, as aggregate, 1.75 parts of limestone flakes and dust (or carbonate aggregates from sand quarries) and trowel the surface. If the 3rd article is applied, in the application of the plaster to be rebuilt on the vault and partly wall surfaces of the house, the binder is 1 part air lime (50% ± 2 hydrated cream lime), the additive is 0.25 part pozzolan, its aggregate is 4 mm under sieve size. It would be appropriate to use a mixture of 0.5 part quartz black sand, 2 parts limestone fragments and dust (or carbonate aggregates to be obtained from sand quarries) and trowel the surface.

It is recommended to use casein added whitewash with pigment(s) that will provide the color that will determine the project, as paint on interior (applied on vaults and walls) plaster surfaces whose cleaning and repair applications have been completed.

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Author contributions

Lale Karataş: Conceptualization, Methodology, Software, Visualization, Investigation, Writing-Reviewing **Aydın Alptekin:** Editing, Writing-Reviewing **Murat Yakar:** Editing, Reviewing.

Conflicts of interest

The authors declare no conflicts of interest.

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