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### Documentation of stone material deterioration on the facades of historical masonry buildings by terrestrial laser scanning: A case study of a Mansion in Mardin

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#### Keywords

Terrestrial Laser Scanning  
Material Deterioration  
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Orthophoto  
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#### Abstract

The traditional house design in Mardin has been determined by some local criteria in parallel with the complex historical process. These are yellow limestone, which is abundant in the region and obtained from quarries in the region, continental climate and topography. Except for the joinery, the only material used in architecture is stone. The subject of this research is an example of civil architecture located in Şar Neighborhood in the Artuklu district of Mardin. The mansion was built in the area where the historical city walls, which no longer exist today, surround the city from the south, in the Sar District of Mardin. The building, which was built on a wide area, carries the characteristics of the historical buildings in the region with its construction technique, plan features and materials. The aim of the study is to detect the stone material deteriorations of the facades of the mansion, which is a traditional masonry building, by terrestrial laser scanning method, and to ensure that this example of civil architecture is transferred to future generations as original. As a result of the study, many types of stone material deterioration were encountered on the facades of the building, such as surface loss, contamination-blackening, plant formation, melting, joint loss and salinization.

#### 1. Introduction

Moisture content in the atmosphere, heat, rain, wind, temperature changes, chemical reactions and corrosion are factors of deterioration for the building blocks. Exposure of building materials to atmospheric conditions for a long time causes various types of deterioration in building facades. This deterioration turns into physical and chemical wear of building materials in later stages. Physical and chemical weathering, on the other hand, causes the formation of chemical and mechanical processes that cause damage to the microstructure and the expansion of micro cracks (Karataş, 2016; Karataş, 2022; Karataş et al., 2022).

The rich architectural heritage of our Turkey is also manifested in stone monuments. The building, which is the subject of the study, is located in the Şar Neighborhood of the Artuklu district of Mardin Province which has the characteristics of historical buildings in the region with its construction technique, plan features and materials. As in many buildings in the region as construction material, there is an intense use of stone

materials in the historical building examined. The aim of the study is to detect the stone material deteriorations in the building by terrestrial laser scanning method and to ensure that this civil architectural example is transferred to future generations as original.

#### 2. Method

In the study, literature review, archive research and terrestrial laser scanning method were used. First of all, the information about the building was compiled from the archive of the Mardin Metropolitan Municipality. Afterwards, field research was carried out and the structure was scanned with a terrestrial laser scanner (Faro Focus Laser Scanner) (Figure 1).

Point clouds were obtained in the scanning process. The point clouds obtained in the laser scanning process were transferred to the software called PointCab Origins 4.0. In the next stage, orthophotos of the structure were produced by taking sections from the desired places on the 3D images of the structure using the software called PointCab Origins 4.0 (Figure 2-5).

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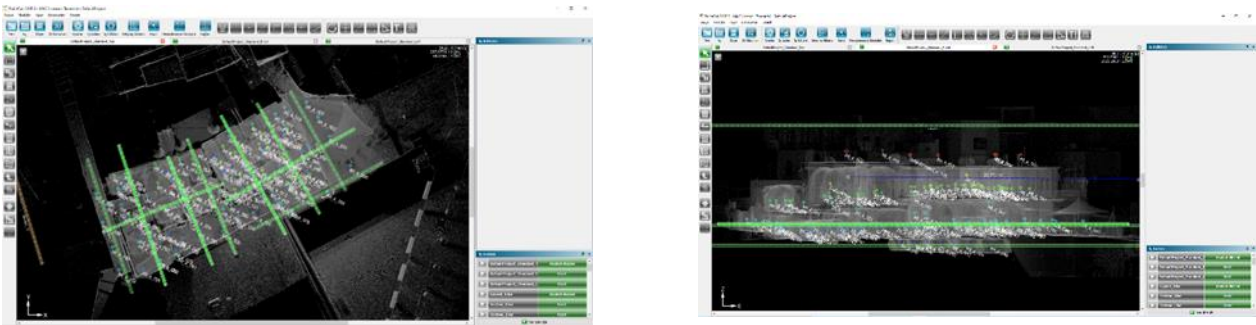


Figure 1. Stations used in scanning

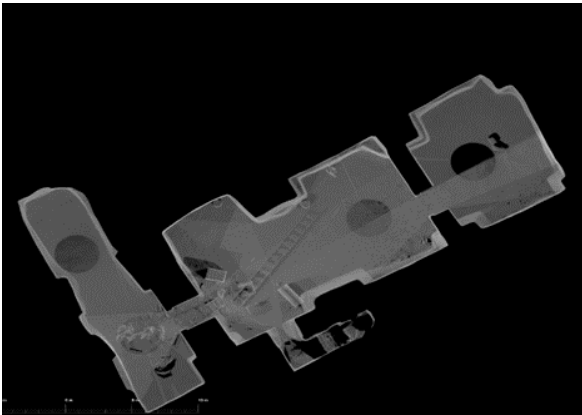


Figure 2. Orthophoto of the Layout Plan

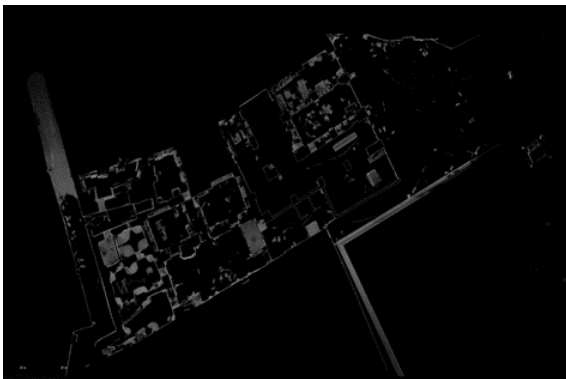


Figure 3. Orthophoto of the Ground Floor Plan



Figure 4. Orthophoto of the Western Front



Figure 5. Orthophoto of the Eastern Front

### 3. Results

After comparative evaluation of the analytical drawings obtained from the orthophotos obtained from the laser scanning made in the previous section, the following findings were reached. Relief drawings of the floor plans and facades of the building were created from the orthophotos obtained from the scanning. Material deteriorations were analyzed on the facade surveys created. The building consists of basement, ground floor and 1st floor and covers a total area of 623 m<sup>2</sup>. The building itself consists of different parts. The analysis was made by considering these sections. The ground floor was divided into 5 sections and examined. 3 separate courtyards and spaces associated with the courtyard are grouped. In addition, the stores and warehouses facing the east façade were separated and analyzed. The 1st floor plan, like the ground floor, was analyzed in 5 separate sections.

#### 3.1. Floor Plans

The building consists of basement, ground floor and first floor. The basement floor area is 72 m<sup>2</sup> and consists of 3 separate spaces. The spaces are made of rubble stone. The floor covering is concrete screed. The ceiling is in the form of a vault. The building consists of 5 separate sections on the ground floor and the 1st floor, and each section is functional in itself (Figure 6-8).

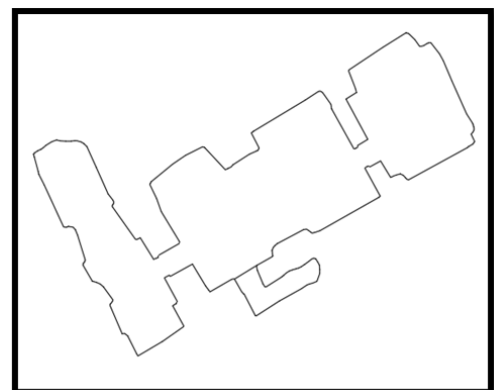


Figure 6. Basement Floor Plan

#### 3.2. Western Front

The western façade of the building is the side entrance façade and has a total length of 23 m. The building facade height is 3.51 m at the lowest and 9.45 m at the highest. The façade wall of the building was built with rubble stone and faceted stone (Figure 9).

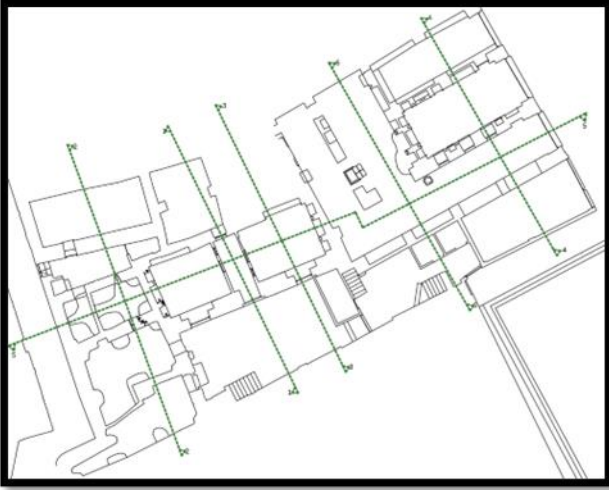


Figure 7. Ground Floor Plan

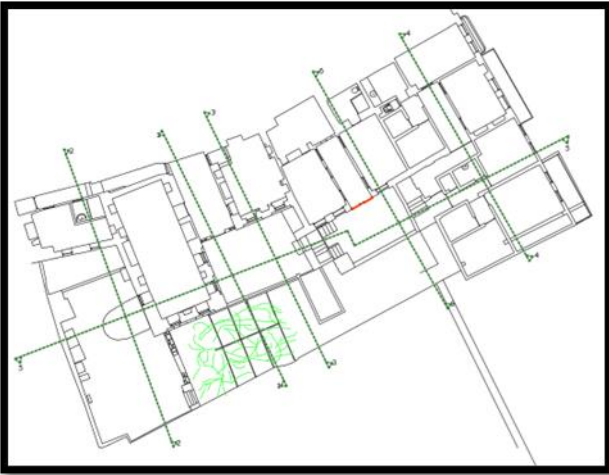


Figure 8. First Floor Plan



Figure 9. Western Front

### 3.3. Eastern Front

The eastern façade of the building is the entrance façade of spaces such as workshops and shops. Its total length is 17 m and the facade height is 9.10 m. The facade wall is covered with stone and rubble stone, and some of it is plastered with cement-based mortar (Figure 10).



Figure 10. Eastern Front

### 4. Conclusion

The study, based on terrestrial laser scanning research, combines the data obtained from laser scanning with various techniques for the analysis of material deterioration of stone facades with data obtained from on-site inspection, focusing on the documentation of material deterioration of stone facades. The study is important in that it systematically exemplifies the methods of creating a base for documenting material deterioration by converting the data obtained from laser scanning into orthophotos, which are necessary for the preservation of original materials in historical buildings. With the study, the material deterioration of the building was determined and the information reflecting the original state of the building was transferred and it was aimed to transfer these civil architectural examples to future generations as originals. As a result of the study, many types of stone material deterioration were encountered on the facades of the building, such as surface loss, contamination-blackening, plant formation, melting, joint loss and salinization.

It is seen that the structures that have similar features with our construction in Mardin Province were generally built in the 19th and 20th centuries. During the preparation and implementation of the renovation and restoration project, emphasis should be placed on preserving the original qualities, minimizing the interventions, and applying the traditional material, technique and construction system. Building elements with wear and deterioration should be repaired by adhering to the original condition.

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