RECORDING AND ANALYZING THE PATHOLOGY IN OTTOMAN MOSQUES

M. LOUKMA & M. STEFANIDOU
Laboratory of Building Materials, School of Civil Engineering, Aristotle University of Thessaloniki, Greece.

ABSTRACT

The Ottoman mosques are an important piece of the historic and cultural heritage of Greece. They are robust and austere structures and served as religious centers during a specific period of time, while some of them have been used for different purposes over the centuries. Currently, they belong to the Ministry of Culture and are designated as historical monuments. Nevertheless, serious issues regarding their preservation status need to be dealt with.

A group of nine mosques that have not been restored and maintain their morphology is recorded in the present study. The way they were built, the environment of the monuments, the building materials, the interventions and the natural disasters create the context of the pathology of these constructions. Therefore, recording and studying the process of deterioration is crucial for the establishment of compatible restoration measures.

The present study focuses on mapping the pathology of the Ottoman mosques that are scattered in the region of Macedonia, North Greece. The study indicates that the above-mentioned factors result in structural problems of a geometric form, i.e. loss of material, declinations due to movements and mechanical problems due to cracks, render loss, disintegration, salt gathering etc. These damages are mainly caused due to abandonment and the aging of construction materials, as well as the lack of systematic maintenance. Important factors of disintegration are, also, the biological factor and the humidity coming from the roof, which in most cases has been destroyed, or rising from the ground.
Keywords: construction materials, domed mosques, material deterioration, Ottoman mosques, pathology.

1 INTRODUCTION

The Ottoman presence in most parts of Greece lasted for approximately five centuries, from the late 14th to the early 20th century. The installation of the Muslim population in conquered areas resulted in the foundation of buildings to serve their needs. As a consequence, new public buildings, commercial and religious, were constructed. It is true that public space was influenced by the location of central mosques and the surrounding buildings as well as by covered markets and inns. The importance of the mosque in everyday life is clearly indicated by its location in the city centre and is about fulfilling the religious duties and social ideals of the Muslim citizens [1].

In general, the mosques that survived in the region of Macedonia can be described as robust, cubic volume buildings, consisting of a quadrangle or multifaceted site with pointed or semicircular openings in all their facades and roofed by one or more domes. The presence of a tall minaret highlights the presence of a mosque in the area.

The buildings are mainly constructed with stones, bricks and mortar, while the domes are made of bricks and mortar. The durable materials have contributed to their survival through time. The current condition of these monuments depicts the influence of time as well as environmental and human interventions.

The research showed that some of these monuments have been rebuilt, others have been repurposed, while a small number of them has been preserved or restored and function as venues for cultural events [2], while others suffer from demolition and abandonment.

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Nowadays, they belong to the Ministry of Culture, which is responsible for their preservation. The aim of this article is to record the symptoms of pathology of these mosques in order to understand the mechanism of degradation and to suggest preservation measures.

2 DESCRIPTION OF THE MOSQUES' CURRENT CONDITION

The buildings under study were constructed to cover mainly the religious needs of the Muslim inhabitants who settled in the region of Macedonia. With the relocation of the Muslim population, these buildings ceased to meet the needs for which they were constructed, and they were neglected. In most cases, these buildings had new use and function in order to meet the needs of the new residents without losing their historical identity. Because of the extensive need for more space in densely populated areas, interventions were made altering decisively the image of these buildings.

The studied monuments have not been restored and the degree of preservation varies, presenting: intense damage, multiple interventions and successive conversions but mainly lack of maintenance. They are located in the city of Kastoria (Koursoum mosque [3]), in Edessa (Yeni mosque [3]), in Veria (Orta mosque [3]), in Giannitsa (Ahmet Bey mosque [3], Iskender Bey mosque), in the city of Serres (Mustafa Bey mosque, Mehmet Bey mosque), in Exochi of Drama [3] and in the city of Drama (Arap mosque) as indicated in Fig. 1.

The mosques under consideration fall into two categories regarding their construction materials [4]. The first category includes the mosques that were built with rows of stones and bricks, with a variety of types and mortar (Koursoum, Ahmet Bey mosque, Iskender Bey mosque, Mustafa Bey mosque, Mosque of Exochi, Arap Mosque). The second category includes the ones that were built with stones and mortar (Yeni mosque, Orta mosque, Mehmet Bey Mosque), while the domes, in both categories, are built exclusively with bricks and mortar. The available materials in the region were linked with the construction techniques and have played an important role in the architectural design. The building materials were

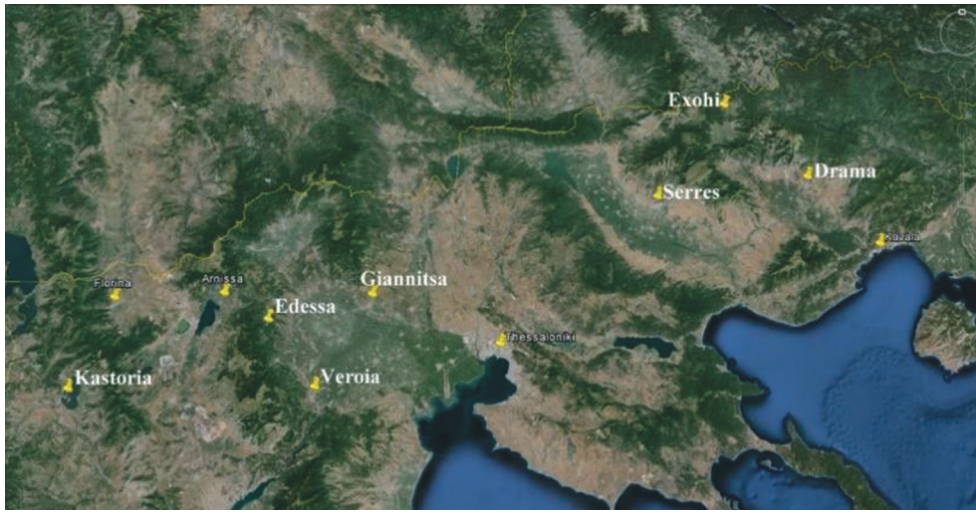

Figure 1: Map of Northern Greece with the cities where the studied Ottoman mosques are located.

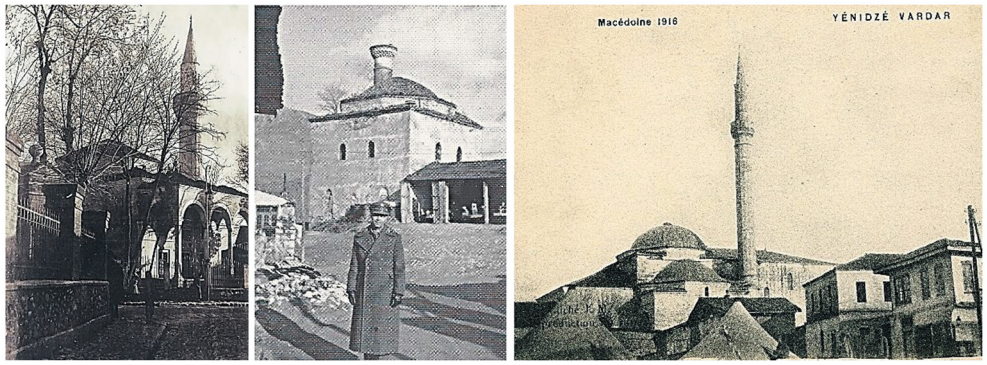

Figure 2: Photographs of mosques in the early 20th century: (a) Arap mosque, (b) Koursoum mosque and (c) Iskender Bey mosque.

mainly stones, bricks, mortars and wood. Other materials such as marble, tiles, lead sheets and metal were used to lead construction to its final form.

2.1 Morphological and construction interventions

The historic analysis shows that during their original function, some mosques were renovated. The phases of renovation concern mainly repairs of roofing materials (Iskender Bey mosque [5], Mehmet Bey mosque [6]), change of entrance and alterations in their morphological characteristics (Ahmet Bey mosque [7]). In some cases, there is evidence, mainly due to the different way of construction, that the minaret preexisted (Arap mosque [8], Fig. 2a) or it is most likely that it belonged to a different construction phase (Koursoum mosque, Fig. 2b, Orta mosque, Iskender Bey mosque, Fig. 2c).

After 1912, the need to adjust the buildings to different uses resulted in interventions that altered their character. The buildings, after removing the furniture, were coated inside, while additions and alterations were made to serve their new use [9]. Most of them were used as warehouses, because they had only one spacious room.

According to historical data, the Yeni mosque [10] was used for some years as a museum and then as a warehouse of antiquities, while the Orta mosque [11] in Veria was used for multiple purposes: from military offices, residence, conservatory, a marble factory and finally storage space. In Giannitsa, Ahmed Bey mosque [12] which is located within a military camp served as a bakery until a large part of it was blown up, while the Iskender Bey mosque [13] was turned into a cotton gin for many decades. The Mustafa Bey mosque [6] was a carpentry [6], the mosque in the Exochi of Drama was used as an animal shelter and the Arap mosque [14] in Drama served as the city's Conservatory and timber warehouse.

Mild modifications are recorded in most mosques (Koursoum, Yeni mosque, Orta mosque, Mehmet Bey mosque, Mosque of Exochi and Arap mosque) related to repairs on external walls, changing windows or doors or closing openings. More drastic interventions were made at Mustafa Bey mosque in Serres (Fig. 3a) where besides drill openings, reinforced concrete was used in some parts of the walls and the floor. Most interventions were made to the Iskender Bey mosque in Giannitsa (Fig. 3b) where the form of the mosque is hardly recognizable, due to the new buildings that were added and the concrete slab which divided the building into two levels (vertically).

Figure 3: (a) Moustafa Bey mosque as a carpentry and (b) Iskender Bey mosque as a cotton gin.

3 MAPPING THE PATHOLOGY AND RECORDING THE PROBLEMS

The behaviour of each building can be examined taking into consideration different factors. A critical stage is the in situ registration of identified problems, which are recorded in detail in drawing plans and documented photographically. It is essential to gather information about the original and subsequent building phases, the construction techniques, the alterations, the causes of deterioration and finally the present condition of the monument. At the original drawings, various parameters are mapped as materials, building phases, decay damages and cracks.

Deterioration and damage [15] of the recorded mosques are mainly due to the following factors:

- Lack of systematic maintenance of buildings.
- Ageing of building materials that cause a gradual reduction of their strength.
- The moisture that appears in the form of running water, concentration of salts, rising humidity from the foundations or as downlink from the roof.
- Human interventions that have led to the disruption of the structural behaviour of the building.
- Environmental pollution.

Also, the behaviour of the masonry structure mainly depends on the properties of construction materials, the dimensions of the building, the connections between structural elements as well as the characteristics of the foundation soil.

3.1 Recording of the decay to the studied monuments

In the case of the nine mosques, the problems that were identified and recorded are divided into two distinct groups. The first one concerns the construction of the mosques and the second one the building materials.

3.1.1 Structural problems of geometric and mechanical nature

1. Loss of structural material/structural problems

In Ahmet Bey mosque of Giannitsa (Fig. 4a), loss of a large part of structural materials is recorded. This resulted in the disruption of masonry structure with increasing likelihood

Figure 4: Present state of mosques: (a) Ahmet Bey mosque, (b) mosque in Exochi and (c) Moustafa Bey mosque.

of total collapse. Apparent strain problems of the masonry structure were also recorded in Iskender Bey mosque due to the loss of the dome in the oblong space, strong deviations from the vertical axis of the facade and the complete alteration of its character. In the mosque of Exochi Drama (Fig. 4b), the collapse of porch and part of masonry from the facade of the mosque and the loss of material in the pendentives have caused disruption to the masonry structure. Loss of structural material of walls for the widening of the initial openings was recorded in the Mustafa mosque of Serres (Fig. 4c), during the period that the mosque was altered to carpentry. In addition, in Koursoum mosque the state of preservation of the building is undermined because of the ongoing deconstruction of the building material from the drum of the dome.

2. Biological factor

The unpredictable growth of trees in masonry is the cause of fractures, discontinuities and cracks in the case of Orta mosque of Veria (Fig. 5a). The damages are more apparent in the higher parts of the monument, particularly on the inner part of the dome with many wide cracks and disorganized masonry on the façade at the NE side with removal of building stones. Also, the presence of a tree trunk inside the masonry in the facade (NE corner) of the mosque at Exochi Drama (Fig. 5b) contributes to the deterioration of the already fragile state of the building. In other monuments, biological factors caused less damage of chemical and mechanical nature but are a key factor of their decay (Fig. 5c).

Figure 5: (a) View of the Orta mosque, (b) part of the dome inside the mosque at Exochi and (c) view of Moustafa mosque.

Figure 6: Views of the monuments which show their domes.

3. Roofing loss

The total or partial loss of the roofs is a problem viewed in most of the mosques under study along with the development of biological factors. The environmental conditions and the moisture are the external factors that resulted in the progressive detachment of the interior coating, the corrosion of building materials, the accumulation of biological factors at the surfaces and the presence of cracks due to alteration of the structural cohesion. Total loss of roofing material was recorded in the two mosques of Serres (Fig. 5c, 6a), while in the case of the Orta mosque a very small percentage of the roof has fallen (Fig. 5a). The retention rate of tiles with delamination problems was recorded in Koursoum mosque, on Arap mosque (Fig. 6b) and in the modern wooden roof of the transversal area of Iskender Bey mosque, while the roofing in Yeni mosque (Fig. 6c) and in the mosque of Exochi Drama is in better shape.

4. Cracking

A frequent problem of damage recorded in all these mosques is the cracks. They reduce the strength and constitute an element of discontinuity for domes and walls. Especially, in the case of the Orta mosque (Fig. 7a), interior dome cracks are observed over a large area of the dome with an average range of 5 cm, while similar problems have not been recorded in the other mosques under study. Heavy cracking in the dome is recorded in some areas of mosques that are directly related to the points that there is loss of material due to the charge of large received loads (Fig. 7b). In the other main domes of prayer hall (with the exception of Mustafa Bey mosque), small cracks appear. In Koursoum mosque, cracks are detected at the corners of a zone between the spherical triangles and the hemispherical dome. On the walls of the mosques, the cracks that were recorded are of a small percentage, starting from the centre of the arch opening endpoint. On the exterior walls of Mehmet Bey mosque (Fig. 7c), cracks

Figure 7: Cracking in the three monuments: (a) Orta mosque, (b) Ahmet Bey mosque and (c) Mehmet Bey mosque.

Figure 8: Loss of wooden tie-beam from (a) Koursoum mosque, (b) Moustafa Bey mosque and presence of metal tie-beam from (c) Arap mosque.

occur in the openings. In Iskender Bey mosque, cracks appear in the intermediate walls of the two halls that start from the front bow.

5. Deconstruction of the buildings

A common problem of medium intensity observed in mosques that are studied is the deconstruction of the masonry mainly inside from a lower level to the point of the first openings due to water activity through capillary absorption from the ground or from the groundwater. The deconstruction appears in the form of coating loss, weakening of the mortar and rot or even loss of wooden tie-beam. In the case of the Orta mosque, construction stones present material degradation and cracks, while the loss of mortar in intermediate bands is observed.

6. Masonry reinforcement tie-beam corrosion (wood-metal)

Another factor that reduces the strength of the walls is the problematic maintenance status of the wooden tie-beam of the mosque masonry and of the arches. On the walls of mosques that are studied, the loss of coating combined with the partial disorganization of the masonry uncovered the wooden elements, thus causing their deterioration. In many cases, the tie-beam at the arches has been removed. In the Arap mosque, the metal tie-beam that has been used to reinforce masonry is in good condition and only surface corrosion is observed (Fig. 8).

7. Loss of coatings

The rate of the coating that is preserved in the studied mosques varies. The lack of protection from the weather, the humidity and the biological factor accelerate the ageing pace of coatings. The coating of the outer surfaces of the masonry was preserved except for the Orta mosque, Yeni mosque and Mehmet Bey mosque (Fig. 9a). In some cases, the coating was preserved in layers (Koursoum mosque (Fig. 9b), Ahmet Bey Mosque), while in the mosque of Exochi colours are kept in the borders of the openings with deterioration and discoloration (Fig. 9c). Internally, the plasters have survived in areas over the openings and at the dome. However, many problems due to detachments and collapses have occurred. In many cases, up to two layers of coating by different construction phases are observed, which were covered in recent decades when the buildings served different uses.

8. Flooring material loss

Floor coating material of interiors of mosques in most cases is not preserved or could not be revealed because it is covered with materials and soil. In some cases, the floor was covered with concrete (Orta mosque, part of Moustafa Bey mosque, Ahmed Bey mosque and Iskender

Figure 9: (a) View of Mehmet Bey mosque, (b) loss of plaster at Koursoum mosque and (c) loss of plaster and the presence of colour at the mosque of Exochi.

Figure 10: (a) Presence of concrete on the floor of Iskender Bey mosque, (b) the preserved floor of ceramic tiles at Mehmet Bey mosque and (c) part of preserved floor at Moustafa Bey mosque.

Bey mosque (Fig. 10a)), with no clues as to in which level the original floor was found. On the other hand, at Mehmet Bey mosque (Fig. 10b) and at the smaller area at Mustafa Bey mosque (Fig. 10c) and the Arap mosque, the ceramic plates of the floor can be seen. The conservation status is moderate to poor, with breakages and problems due to the humidity and misuse.

9. Loss of the minaret

The minaret is a key element of the Ottoman architecture and a characteristic part of the mosque. This is a tall structure adjacent to or embodied in the construction of the mosque. Nowadays, in the Ottoman mosques under consideration, the preservation state varies. The whole construction is preserved in only one case (Yeni mosque Edessa, Fig. 11a), while there are three cases in which the minaret was demolished but there are traces on the adjacent walls of the mosque (Mehmet Bey Serres Fig. 11b, Mustafa Bey Serres, and mosque in Exochi Drama). In the cases of other mosques studied, there is a preserved section of the minaret, especially the four-sided base and part of the circular section with an inner staircase (Fig. 11c).

10. Environmental aspects

A special problem occurs in Mehmet Bey mosque (Fig. 12) due to its location within a stream influencing the conservation status. A major cause of deterioration of the building since its construction was the overflows of the stream. River sediment and water disrupt the structure of the building and accelerate the decay of the materials. Today, a big part of its external

Figure 11: (a) View of the minaret of Geni mosque, (b) the demolished minaret of Mehmet Bey mosque and (c) part of the preserved minaret of Arap mosque.

Figure 12: Views of Mehmet Bey mosque where the interior and exterior space is full of debris.

facades is covered with these materials, and internally almost the whole western space is full of debris. The moisture affects both the appearance of the monument and the properties of the construction materials. The stones are generally in good condition, although in the areas up to the second zone of openings, deterioration of materials, detachment fragments and colour alteration are observed.

3.1.2 Physicochemical and biological processes in building materials

The main building material used in all case studies was limestone (Fig. 13a), ceramic plates (Fig. 13b), mortar as a binder or as a coating (render/plaster) and wood or metal to reinforce the walls. Physicochemical processes act on materials by changing their characteristics and leading to decay affecting mainly their endurance. These actions can be influenced and accelerated due to the presence of water (rain, humidity, groundwater, moisture and drought cycles, growing vegetation, etc.) temperature changes (dilation and constriction, frost, etc.) and microclimate conditions (infection, superficial deposits, changes in wind speed due to adjacent buildings, etc.). Also, the properties of materials can change over the time due to natural processes and the characteristics of the materials (hardening of plaster or the slow internal decay, salts etc.). Chemical character changes can occur due to the inherent characteristics of materials or may arise because of external factors, such as depositions of pollutants, moving water or other elements that operate within the material. The problem recorded in building materials from organic decay is more disruptive mortar structure that varies depending on the location of the monument and the tension that occurs. In bricks and

Figure 13: (a) Masonry of Mehmet Bey mosque, (b) brick wall of the minaret of Arap mosque and (c) the presence of birds.

stones, organic decay occurs ranging from chromatic alteration to mechanical breakage of the structure of the material. Also, to a limited extent, damage is caused by the presence of birds (Fig. 13c) within the buildings, resulting in a negative aesthetic effect or even decay of the building materials.

4 CONCLUSIONS

In this study, a pathology examination of nine Ottoman mosques that are preserved in the area of Macedonia, north Greece, showed that these monuments present various problems. They are buildings located in an urban environment, constructed of masonry with the use of local stones, compact bricks and strong mortars. These monuments are robust and austere structures. The high-quality materials combined with the construction technology of that era contributed to the durability of the whole structures.

The current situation of the monuments is the result of the influence of time, the environment and the multiple human interventions. The pathology of each monument differs and depends to a certain extent on the microclimate and the uses that the building served. The ageing building materials and the long-term lack of maintenance contribute to their relevant low preservation state. The study showed that in those monuments the humidity and the biological attack influence negatively the structures and increase the problems. The range of pathology symptoms in the studied monuments is wide ranging_from demolition to colour alteration of the materials. Detachments and collapses are often, while the disintegration of the bricks and mortar losses are also present. These problems have been created mostly due to abandonment. The collapse of roofs accelerated the disintegration. Biological deterioration is also severe. Factors such as render losses, wood removal and brick alterations should be taken into account in order to understand their properties and proceed to compatible interventions. The present situation though can be reversible through a holistic approach. The present article contributes towards this effort.

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