



PLANNING MALAYSIA:

Journal of the Malaysian Institute of Planners

VOLUME 24 ISSUE 4 (2026), Page 864 – 878

THE KHATABA VENTILATION METHOD: ENHANCING FOUNDATION DURABILITY IN KHIVA'S ARCHITECTURAL MONUMENTS

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Abstract

This article examines the importance of the Khataba method in the restoration and preservation of architectural monuments, especially in the historic regions of Ichan Qala and Deshon Qala in Khiva. The study explains Khataba as a traditional ventilation technique applied to foundations, walls, and roof structures to reduce moisture, salt migration, and capillary absorption, which damage historic materials. Based on historical sources, field observations, and restoration practice, the paper discusses the scientific basis of the method and its application in several monuments. The findings show that the Khataba system improves durability, reduces the harmful effects of groundwater, and contributes to the long-term conservation of monument structures.

Keywords: Architectural monuments, restoration, Khataba, foundations, ventilation, groundwater, capillary absorption, Ichan Qala, Deshon Qala, Khiva

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INTRODUCTION

The Architectural monuments in Central Asia face significant threats from environmental factors that compromise their structural integrity and longevity (Hejazi, 2008). Groundwater rise, capillary moisture ascent, and salt crystallization are primary deterioration mechanisms affecting porous materials such as fired brick and gypsum plaster, leading to foundation instability, wall cracking, and surface degradation (Afif-Khoury et al., 2025; Bochen et al., 2021; Cheema & Bell, 2013). Traditional restoration practices, therefore, emphasize moisture management strategies to enhance durability without compromising historical authenticity (Ehteshami & Soltaninejad, 2020). The importance of moisture management, humidity, and ventilation has been emphasised by (Baydoun et al., 2025).

Restoration efforts worldwide have increasingly adopted ventilation-based techniques to mitigate these issues (Mousavi et al., 2025; Rubulotta et al., 2024). For instance, cavity walls and air gaps in historic masonry structures allow moisture evaporation and reduce salt migration, as demonstrated in European heritage conservation projects (d'Ambrosio Alfano et al., 2023; Proietti et al., 2021). Similarly, in arid regions, passive ventilation systems have proven effective in stabilizing foundations by promoting airflow and drying (Ayoobi et al., 2024; Chohan & Awad, 2022). These approaches align with sustainable conservation principles, minimizing invasive interventions while extending service life.

The Architectural monuments in Central Asia are highly vulnerable to deterioration caused by groundwater, capillary moisture rise, salinity, and poor ventilation in lower structural zones (Arefyeva et al., 2022). To address these challenges, traditional construction and restoration knowledge developed several techniques, among which the Khataba method holds a special place (Durán-Suárez et al., 2018). Khataba is essentially a ventilation-based construction and restoration approach in which an air passage is deliberately left between structural or finishing layers. This air gap allows moisture and salts to dissipate, helps maintain dryness in walls and surface finishes, and ultimately slows the decay of bricks, plaster, and tiles. Historically, master builders in Khorezm and other regions applied this method in foundations, walls, roof spaces, and finishing interfaces. However, over time, many aspects of the technique were forgotten or simplified, and modern repair works often replaced it with direct adhesion methods, which, in many cases, accelerated deterioration.

Previous studies and restoration literature confirm that Khataba has deep historical roots and functioned as a natural ventilation strategy in traditional architecture. Several researchers have also highlighted its significance in restoration practice, including investigations of the Chor-Bakr complex in Bukhara (Anvarovna Nazarova, 2020). In addition, scientists have emphasized

that foundation failures often require careful soil examination, staged repair processes, and structurally sensitive interventions, principles that strongly support the logic of Khataba-type systems when dealing with weak or moisture-affected foundations.

Abdugaffor Hakkulov further explained how roof-related Khataba devices improved ventilation, reduced dampness, and extended the service life of traditional buildings, linking restoration practice with long-term structural performance (Shynu & Steffi, 2023). Similarly, Azizova et al. argue that the Khataba ventilation method represents an important traditional restoration technique that was largely forgotten as architectural knowledge declined. Their research highlights that in Uzbekistan, particularly during the independence period, scholars have increasingly attempted to recover such historical construction practices to improve monument preservation and reconstruction efforts (Azizova, 2017).

The purpose of this article is therefore to systematize the available information on the Khataba method and demonstrate its importance in the ground and foundation zones of the architectural monuments, particularly those restored in Khiva. This study is novel in that it systematically documents the Khataba method as applied to Khiva's architectural monuments, provides a scientific explanation of its moisture-control mechanism, and synthesizes multiple restoration case studies from Ichan Qala and Deshon Qala. By combining historical review, field observation, and semi-quantitative comparison, the paper clarifies both the practical and conservation value of this traditional technique.

THEORETICAL BASIS OF THE KHATABA METHOD

The Khataba method operates on the principle of ventilation and separation. By creating an air chamber between the original wall and a newly formed protective layer, the system reduces direct contact between the monument fabric and moisture-bearing soil or finishing material. This technique is particularly relevant for porous materials such as baked brick and tile, which are susceptible to capillary absorption. In porous media, water rises through small voids, transporting salts upward; this leads to dampness, cracking, plaster failure, and loss of decorative surfaces. The use of a ventilated cavity helps release moisture and harmful salts into the atmosphere. It limits the destructive effect of aggressive groundwater on both underground and above-ground sections of the monument.

Moisture movement in porous masonry materials is primarily governed by capillary action, where water rises through fine pores due to surface tension forces. This process depends on pore size, material composition, and environmental conditions. In historic brick and plaster systems, smaller pore radii lead to higher capillary rise, allowing groundwater to migrate upward and carry dissolved salts. When evaporation occurs, salts crystallize within pores,

generating internal stresses that cause cracking and material loss. This mechanism explains the effectiveness of the Khataba method in interrupting moisture pathways.

Use in Building elements

Traditional Khataba solutions were strategically applied across multiple building elements to create ventilated separations that mitigate moisture accumulation and enhance material longevity. Each application targets specific deterioration risks associated with environmental exposure and material properties.

Foundations of buildings and structures:

Khataba in foundations involves excavating trenches or creating air gaps adjacent to the base, often filled with permeable materials to promote airflow. This prevents capillary rise from groundwater, reducing salt crystallization and foundation settlement in moisture-prone soils common to Khiva's historic sites.

Walls of buildings and structures:

Wall applications feature ventilated cavities between the original masonry and protective layers, such as brick or plaster facings. These gaps facilitate moisture evaporation and salt dissipation, protecting porous fired bricks from efflorescence and cracking while maintaining structural breathability.

Under-roof and upper covering elements:

In roof zones, Khataba forms air channels beneath tiles or coverings to improve circulation and prevent condensation. This technique counters dampness from roof leaks or humidity, extending the lifespan of timber supports and mud-based insulations in traditional Central Asian designs.

Between the roof and wall finishing layers:

Here, thin air passages separate decorative plasters, tiles, or paintings from underlying walls or roofs. This isolation shields ornate surfaces from rising damp and thermal fluctuations, preserving aesthetic and cultural value without direct adhesion that could trap moisture.

Applications in the Khiva monuments

The newly proposed and practically implemented Khataba style was used in the restoration of several monuments in the Ichan Qala and Deshon Qala areas of Khiva. These include the Sayyidniyoz Sholikorboy complex, Bikajon Bika madrasa, Muhammad Amin Inaq madrasa, Mamat Mahram madrasa, Sayyid Mohi Roi Jahan complex, Palvan Qori madrasa, Sayyid Muhammadkhan madrasa, Shergozikhan madrasa, and the Shikhnazar rich house.

RESEARCH AIM AND METHODOLOGY

The aim of this study was to evaluate the scientific and practical significance of the Khataba method and its role in reducing moisture-related deterioration in the architectural monuments. The research combined analysis of historical and scientific sources, review of restoration literature, interviews with traditional master builders, field observations, and direct examination of restoration works carried out in Khiva between 2010 and 2020. The study focused on selected monuments in Ichan Qala and Deshon Qala where Khataba-based interventions were implemented. Fieldwork included observation of foundation conditions, dampness, wall deterioration, and the restoration solutions applied on site. The case study monuments were selected because they represent restored historic structures in Ichan Qala and Deshon Qala where the Khataba method was applied and where visible moisture-related deterioration was documented. Selection was based on the presence of foundation dampness, salt crystallization, structural risk, and the availability of restoration records. In addition, interviews were conducted with traditional master builders and restoration practitioners involved in the works to clarify construction details and practical application of the method. Field observations were recorded through site notes, photographs, and direct visual inspection, and the observed conditions were compared by examining the same deterioration indicators before and after intervention. The before-and-after assessment focused on visible moisture, salt damage, and surface deterioration, using a semi-quantitative scale to classify each condition consistently across the selected monuments. Figure 1 and Table 1 present the monuments examined in this study.

To support comparison across case studies, a semi-quantitative assessment framework was used. Each monument was evaluated using three observable indicators: moisture presence, salt crystallization, and surface deterioration. Moisture was classified as low, moderate, or high according to visible dampness. Salt damage was categorized as none, moderate, or severe based on efflorescence. Surface deterioration was recorded in terms of cracks, plaster detachment, and brick erosion. This framework made it possible to compare conditions consistently before and after the intervention.

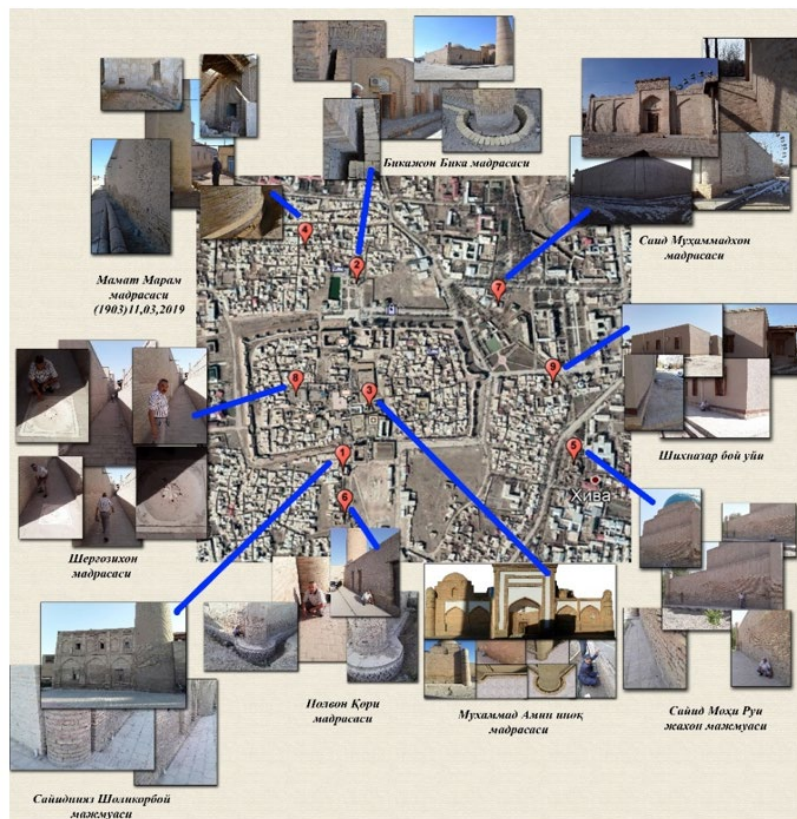


Figure 1: Objects in Ichan Qala and Deshon Qala where the Khataba method was used and their location on the scheme.

Table 1: Monuments in Khiva where the Khataba method was applied

Monument	Location	Main problem observed	Khataba application
Sayyidniyoz Sholikorboy complex	Deshon Qala	Rising groundwater, tilt, structural risk	Ventilated foundation-zone device with protective brick wall
Bikajon Bika Madrasa	Deshon Qala	Dampness and salt damage in lower walls	Trench-type Khataba along wall perimeter
Muhammad Amin Inaq madrasa	Ichan Qala	Foundation moisture and deterioration	Trench-like Khataba on all four sides

Monument	Location	Main problem observed	Khataba application
Mamat Mahram madrasa	Khiva	Moisture-related monument protection	Khataba-based restoration mentioned in the study
Sayyid Mohi Roi Jahan complex	Khiva	Monument preservation intervention	Khataba-based restoration mentioned in the study
Palvan Qori madrasa	Khiva	Monument preservation intervention	Khataba-based restoration mentioned in the study
Sayyid Muhammadkhan madrasa	Khiva	Monument preservation intervention	Khataba-based restoration mentioned in the study
Shergozikhon madrasa	Khiva	Monument preservation intervention	Khataba-based restoration mentioned in the study
Shikhonazar rich house	Khiva	Monument preservation intervention	Khataba-based restoration mentioned in the study

CASE STUDY: SAYYIDNIYOZ SHOLIKORBOY COMPLEX

A comparative evaluation was conducted to assess the performance of the Khataba method across selected case studies. The analysis focuses on changes in moisture levels, salt crystallization, and surface condition before and after intervention. Although precise measurements were not available, consistent improvement patterns were observed. The Sayyidniyoz Sholikorboy complex, located in the eastern part of Deshon-Kala near the Polvan Gate, experienced serious structural risk due to rising groundwater, traffic-related dynamic effects, and failures in water and sewage systems. The tower had a height of 30.5 meters and a tilt of 1.07 meters toward the northwest, indicating an emergency condition. To reduce these threats, the Khataba method was applied to the foundation zone. A trench was excavated along the wall, and on the opposite side, a protective brick wall was constructed while leaving a ventilated space near the original foundation. Buttresses were introduced at intervals to improve the stability of the added structure. Figure 2 presents the cantilevered Khataba device used in the Sayyidniyoz Sholikorboy complex, together with the related foundation settlement diagram and construction details. The main types of Khataba application and their functions are listed in Table 2.

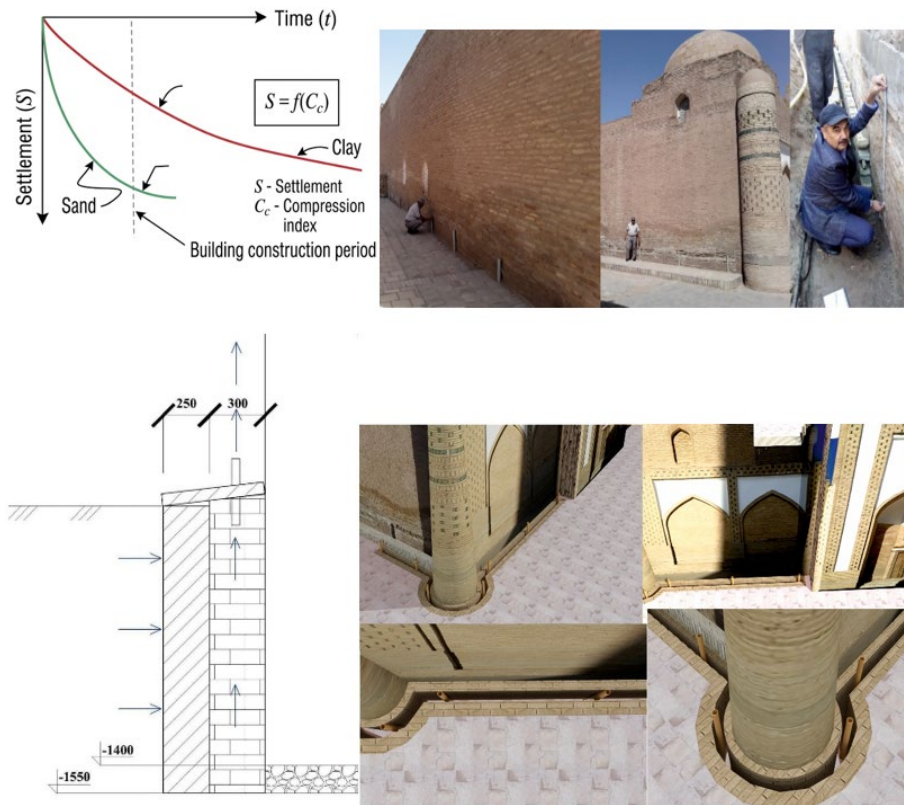


Figure 2: Cantilevered Khataba device used in the Sayyidniyoz Sholikorboy complex, including the foundation settlement diagram and construction details.

Table 2: Types of Khataba application and their functional purpose

Khataba type	Structural location	Main purpose	Expected effect
Foundation Khataba	Foundations and plinth zones	Reduce direct moisture contact	Limits capillary rise and dampness
Wall Khataba	Wall layers	Create a ventilated separation layer	Improves drying and salt release
Roof Khataba	Under-roof and upper cover elements	Improve air circulation	Reduces condensation and dampness

Khataba type	Structural location	Main purpose	Expected effect
Finishing-layer Khataba	Between the roof and wall finishes	Separate decorative layers from moisture sources	Protects plaster and tile surfaces
Trench-type Khataba	Along perimeter walls	Provides a ventilated protective trench	Helps stabilize moisture-prone foundations
Cantilevered Khataba	Foundation-adjacent protective structure	Strengthen foundation protection	Improves durability under settlement risk

CASE STUDY: BIKAJON BIKI MADRASA

The Bikajon Biki madrasa and minaret, restored in 1894 and located in Deshon Qala, showed visible dampness and salt-related brick damage in the lower wall and plinth zones. The general view of the Bikajon Biki madrasa from the north-east is shown in Figure 3. In this monument, two Khataba variants were used depending on the local structural and environmental conditions. A trench 50-60 cm wide was dug along the wall, and baked brick was laid opposite the monument wall while maintaining a ventilated gap of about 25-30 cm from the foundation. The trench-type Khataba system applied to the eastern wall of the Bikajon Biki madrasa is illustrated in Figure 4. On the northern facade, which faced the roadway, the ventilation shaft was filled with rubble stone to improve resistance to dynamic vibration caused by heavy traffic. The ventilation shaft in the northern wall, filled with rubble stone for added stability, is shown in Figure 5. Restoration views of the northern facade, including pre- and post-intervention details, are presented in Figure 6. Application of the trench-type Khataba system on the northern and northeastern walls is depicted in Figure 7.



Figure 3: General view of the Bikajon Bika madrasa from the north-east.



Figure 4: Application of the trench-type Khataba system on the eastern wall of the Bikajon Bika madrasa.

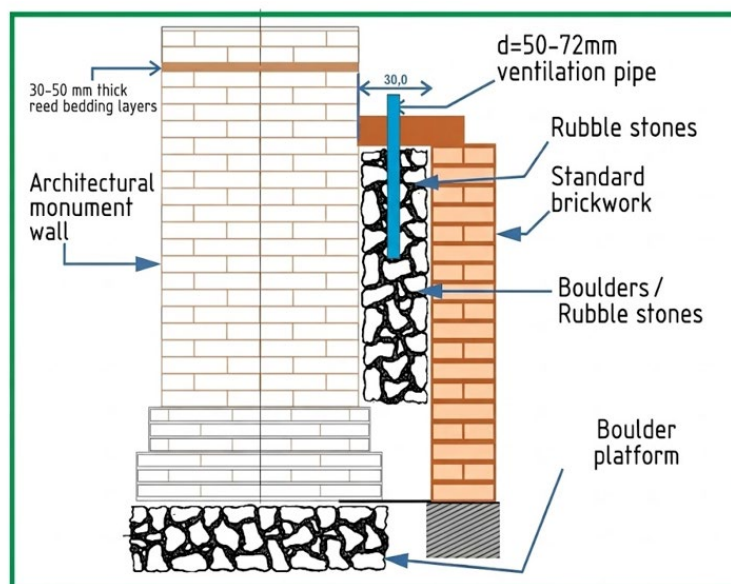


Figure 5: Ventilation shaft in the northern wall of the Bikajon Bika madrasa filled with rubble stone.



Figure 6: Northern facade of the Bikajon Bika madrasa and related restoration views.



Figure 7: Application of the trench-type Khataba system on the northern and northeastern walls of the Bikajon Bika madrasa.

CASE STUDY: MUHAMMAD AMIN INAQ MADRASA

The Muhammad Amin Inaq madrasa in Ichan Qala was built in 1780-1785 and later underwent several repairs, including interventions in the foundation, plinth, roof, and dome areas. In this monument, the foundation was treated with a trench-like Khataba system along all four sides. A 50-60 cm wide trench was dug along the walls, and ordinary baked bricks were laid opposite the original monument wall using a cement-sand mixture. The spacing between the new brickwork and the original foundation was maintained to preserve ventilation and reduce moisture accumulation.

SUMMARY OF RESULTS

Table 3 summarizes the observed condition of the selected monuments before and after application of the Khataba method. The comparison shows a general reduction in moisture level, salt crystallization, and surface deterioration after intervention.

Table 3: Summary of Before-and-After Condition Assessment for Monuments Treated with the Khataba Method

Indicator	Before Khataba	After Khataba
Moisture level	High	Moderate
Salt crystallization	Moderate to high	Low to moderate
Surface deterioration	High	Moderate

DISCUSSION

Field observations and restoration practice indicate that the Khataba method effectively reduces the adverse effects of groundwater and capillary moisture on monument foundations and lower walls. By ventilating the foundation perimeter, it helps preserve both finishing layers, such as plaster and tiles, and the structural body of the monument by limiting dampness, corrosion, and salt accumulation. This also has an economic benefit, as preserving the original fabric and reducing the need for repeated repairs can lower restoration costs over time. In this sense, Khataba functions not only as a conservation technique but also as a sustainable maintenance strategy.

The effectiveness of the Khataba system is related to its influence on moisture transport. The ventilated cavity interrupts capillary continuity between the soil and the wall and promotes evaporation through airflow, thereby reducing moisture retention and limiting salt crystallization. These processes help explain the improved condition observed in the treated structures.

Compared with other traditional moisture-control strategies reported in heritage conservation, such as cavity walls or passive ventilation systems, the Khataba method offers a similar benefit of allowing moisture to dissipate while preserving material breathability. Its advantage is that it is closely adapted to the construction logic of historic masonry in Khiva, where ventilated gaps are created in foundations, walls, and roof interfaces without relying on impermeable barriers. Unlike chemical damp-proofing or rigid membranes, Khataba is more compatible with original materials and is easier to integrate into traditional restoration practice. At the same time, it should be viewed as a complementary strategy rather than a complete substitute for modern waterproofing when severe groundwater pressure is present.

Compared with modern damp-proofing methods such as chemical barriers and impermeable membranes, Khataba is better aligned with traditional materials, reversible in principle, and more environmentally sustainable. At the same time, its performance depends on construction quality and local environmental conditions, and it does not completely prevent moisture ingress. For this reason, it should be regarded as a complementary conservation solution rather than a full replacement for modern waterproofing systems.

LIMITATIONS

This study is based on qualitative and semi-quantitative observations without instrument-based measurements. The findings are specific to the environmental conditions of Khiva and may not be fully generalizable. Future research should include sensor-based monitoring and laboratory validation.

CONCLUSION

The study shows that moisture, groundwater, and capillary absorption remain among the main threats to the preservation of the architectural monuments in Khiva. These processes lead to damp foundations, salinity, swelling, and cracking of walls, and the deterioration of plaster and tile surfaces. The renewed Khataba method provides an effective response to these problems by introducing ventilation around the foundation perimeter and between structural layers. Its practical use in several monuments of Ichan Qala and Deshon Qala confirms that it can improve structural durability and support long-term preservation. Therefore, the Khataba method should be recognized as an important traditional restoration principle that deserves further study and wider use in the conservation of architectural heritage. This study provides a structured validation of the Khataba method as a passive moisture-control strategy suitable for sustainable heritage conservation. For conservation practitioners and heritage authorities, the Khataba method can be used as a low-intervention moisture-control strategy in monuments where preserving traditional fabric is a priority. Future studies should include quantitative monitoring with moisture sensors and longer-term performance evaluation to verify durability under different environmental conditions.

ACKNOWLEDGMENT

This research supported by BKB 050 grant, university Malaya with collaboration with Tashkent university of architecture and civil engineering TAQU.

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Received: 24th June 2026. Accepted: 27th June 2026