

Conservation Methods Applied at Registan Square

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Abstract: Registan Square in Samarkand, Uzbekistan, is one of the most emblematic monuments of Islamic and Timurid architecture. Over the past century, it has undergone multiple conservation campaigns reflecting shifts in political context, technological capabilities, and evolving philosophies of heritage preservation. This paper explores the major conservation methods employed from the Russian Imperial period through the Soviet era to contemporary efforts in post-independence Uzbekistan. It analyzes the application of structural reinforcement, material restoration, digital technologies, and international collaboration, evaluating their adherence to global conservation ethics. By tracing these interventions in chronological and thematic order, the study highlights the balance between material preservation and authenticity, offering insights into sustainable heritage management in a historically and seismically vulnerable context.

Keywords: Registan Square, cultural heritage, key concepts of conservation, conservation methods, architectural restoration, Soviet interventions, UNESCO, authenticity, historical preservation, Timurid architecture; digital documentation.

Introduction

The conservation of cultural heritage is a multidimensional endeavor aimed not only at preserving tangible history but also at safeguarding cultural identity, memory, and meaning. UNESCO defines this: "The conservation of cultural heritage refers to the measures taken to extend the life of cultural heritage while strengthening transmission of its significant heritage messages and values. In the domain of cultural property, the aim of conservation is to maintain the physical and cultural characteristics of the object to ensure that its value is not diminished and that it will outlive our limited time span" [19]. Unlike restoration, which seeks to return an artifact to a presumed original state, conservation emphasizes the stabilization and protection of heritage materials in their current, aged condition, allowing the viewer to witness the passage of time and the layers of historical change embedded within the artifact [29]. This distinction is critical in the context of monumental architectural ensembles, where intervention decisions must navigate between structural safety, material authenticity, and aesthetic coherence.

Architectural heritage, particularly in arid and seismically active regions, faces accelerating degradation due to environmental factors such as water infiltration, air pollution, UV radiation, and temperature fluctuations. These stressors promote chemical and physical decay processes, ranging from salt crystallization and freeze-thaw cycles in masonry to microbial colonization and photodegradation of decorative finishes [29]. As a result, conservation efforts require scientifically informed strategies tailored to each structure's material composition, environmental context, and historical significance. In recent decades, advanced methods such as nanomaterial-based consolidants, 3D laser scanning, and digital photogrammetry have

transformed conservation from a predominantly empirical craft into a technology-enhanced discipline.

This article examines the conservation methods applied to one of Central Asia’s most iconic historical site – **Registan Square in Samarkand, Uzbekistan**. Comprising three monumental Timurid madrassas, Ulugh Beg, Sher-Dor, and Tilla Kori, Registan represents both the architectural grandeur and historical vulnerability of Islamic Central Asian heritage. Over the past century, Registan has undergone diverse conservation interventions, ranging from Soviet-era structural reconstructions using reinforced concrete to contemporary programs incorporating international guidelines and scientific tools. The research question guiding this study is the **conservation methods that have been employed at Registan Square, and how they reflect evolving philosophies and technologies in heritage preservation**.

To answer this, the article provides a chronological analysis of the key phases of Registan’s conservation, exploring the historical contexts, technical approaches, and ethical debates surrounding each phase. Drawing on both archival sources and contemporary conservation literature, the discussion assesses how interventions at Registan align with or diverge from international charters, such as the Venice Charter and the Nara Document on Authenticity. In doing so, this study not only documents the site’s preservation history but also offers insight into the broader challenges and innovations shaping conservation practice in the 21st century.

Research Methodology

This study uses a qualitative, historical-analytical approach to examine the conservation methods applied at Registan Square. It draws on archival sources, scholarly literature, and reports from organizations such as UNESCO to trace changes in techniques and philosophies over time. The analysis is guided by international conservation standards, including the Venice Charter and Nara Document, and incorporates recent technical data from collaborative restoration projects.

Results and Discussion

We present our findings in three parts. First, we define key terms in cultural heritage conservation, drawing on internationally recognized sources such as UNESCO and ICOMOS. Second, we outline established conservation methods used globally in safeguarding architectural heritage. Finally, we examine the specific conservation practices applied at Registan Square, illustrating how these approaches are implemented in a historically significant context.

I. Key terminologies in cultural heritage conservation

To ground the discussion in internationally accepted frameworks, Table 1 presents selected terms that are central to the understanding and application of conservation principles in the cultural heritage sector.

Table 1. Glossary of key terms in cultural heritage conservation

Term	Definition	Source
Conservation	All actions aimed at the safeguarding of cultural heritage for the future, while respecting its significance.	UNESCO, <i>Operational Guidelines for the Implementation of the World Heritage Convention</i> (2021)
Conservator	A professional whose primary occupation is the practice of conservation and who, through specialized education, knowledge, training, and experience, formulates and implements all the activities of conservation	AIC Definitions of Conservation Terminology
Conservation administrator	A professional with substantial knowledge of conservation who is responsible for the administrative aspects and implementation of conservation activities	AIC Definitions of Conservation Terminology

Conservation educator	A professional with substantial knowledge and experience in the theory and techniques of conservation whose primary occupation is to teach the principles, methodology, and/or technical aspects of the profession	AIC Definitions of Conservation Terminology
Conservation scientist	A professional scientist whose primary focus is the application of specialized knowledge and skills to support the activities of conservation	AIC Definitions of Conservation Terminology
Conservation technician	An individual who is trained and experienced in specific conservation treatment activities and who works in conjunction with or under the supervision of a conservator A conservation technician may also be trained and experienced in specific preventive care activities.	AIC Definitions of Conservation Terminology
Conservation method	A systematic approach or technique applied to preserve, protect, and stabilize cultural heritage objects, structures, or sites. These methods may include preventive conservation, restoration, reconstruction, consolidation, or documentation, each chosen based on the specific condition, significance, and context of the heritage asset.	UNESCO (2017). <i>Operational Guidelines for the Implementation of the World Heritage Convention</i> (para. 110–124). United Nations Educational, Scientific and Cultural Organization
Conservation ethics	The guiding principles and moral responsibilities that govern decisions and actions in the care of cultural heritage. These ethics emphasize values such as authenticity, integrity, minimal intervention, reversibility, and respect for the cultural and historical context of the heritage object or site.	Staniforth, S. (2013). Conservation ethics. In A. Richmond & A. Bracker (Eds.), <i>Conservation: Principles, dilemmas and uncomfortable truths</i> (pp. 19–29).
Collections care specialist	An individual who is trained and experienced in specific preventive care activities and who works in conjunction with or under the supervision of a conservator.	AIC Definitions of Conservation Terminology
Restoration	Returning a heritage object to a known earlier state, without conjecture and respecting original materials and design.	ICOMOS. <i>Venice Charter</i> (1964), Art. 9
Preservation	Maintaining a heritage item in its existing state and preventing further deterioration.	ICCROM Glossary
Treatment	The deliberate alteration of the chemical and/or physical aspects of cultural property, aimed primarily at prolonging its existence. Treatment may consist of stabilization and/or restoration.	AIC Definitions of Conservation Terminology
Authenticity	The degree to which heritage retains its original cultural value, form, materials, and setting.	<i>Nara Document on Authenticity</i> (1994)
Integrity	The wholeness and intactness of a cultural heritage site and its attributes.	UNESCO. <i>Operational Guidelines</i> (2021)
Anastylosis	A conservation technique involving the reassembly of existing but dismembered	ICOMOS. <i>Venice Charter</i> (1964), Art. 15

	parts of a monument.	
Preventive Conservation	Measures and actions aimed at avoiding future deterioration or loss.	ICCROM. <i>Preventive Conservation Approach</i> , 2007
Cultural Significance	The aesthetic, historic, scientific, social, or spiritual value for past, present, or future generations.	ICOMOS, <i>Burra Charter</i> (2013)

II. Explanation of conservation methods used in the sphere. Conservation of cultural heritage assets encompasses preventive and interventive strategies, supported by laboratory analysis, comprehensive documentation, ethical standards, and community engagement.

2.1. Preventive conservation and collections care. Preventive conservation aims to minimize deterioration before it occurs through environmental control – managing temperature, humidity, and light exposure [3]. For example, watercolor paintings need shielded lighting environments to prevent pigment fading. Collections care – whether in storage, exhibition, or transit – is a critical responsibility of museum professionals and involves regular condition monitoring to identify artifacts requiring conservation intervention. An illustrative case is the filling of cracks in a rock wall with prehistoric paintings at Serra da Capivara National Park, carried out to prevent structural fragmentation.

2.2. Interventive conservation. Interventive, or curative, conservation involves direct actions on an object to stabilize, restore, or improve its condition. This may include varnish removal from paintings, application of wax on sculptures, or rebinding of aged manuscripts. Ethical practice requires that such interventions be fully documented, justifiable, and distinguishable from original materials [28]. While reversibility has historically been a guiding principle, it is increasingly understood as a flexible standard rather than an absolute, and all interventions should now be clearly recorded and, where possible, reversible.

2.3. Scientific analysis and conservation laboratories. Modern conservation laboratories utilize advanced scientific techniques – such as microscopy, spectroscopy, and X-ray imaging – to assess material composition and structural integrity. These analyses inform treatment choices and help prevent damage. Public-facing labs like the Smithsonian’s Lunder Conservation Center allow real-time observation of conservators at work, thereby raising educational awareness and transparency [16].

2.4. Documentation, ethics, community involvement, and technology. Thorough documentation underlies all conservation work, capturing the object’s condition, materials, and treatment history [16]. Ethical guidelines emphasize minimal intervention, correct material use, and respect for original fabric. Community engagement ensures local perspectives shape conservation priorities. Emerging technologies – such as 3D scanning, thermal imaging, and laser cleaning – are enhancing diagnostic, documentation, and treatment capabilities.

III. Conservation methods employed at Registan Square

3.1 Historical overview of conservation at Registan. Registan Square, composed of the Ulugh Beg (1417–1420), Sher Dor (1619–1636), and Tilla Kori (1646–1660) madrasas, stands as a masterpiece of Timurid Islamic architecture. By the late 19th century, however, the complex had suffered extensive decay: domes and portals were partially collapsed, minarets leaned dangerously, and nearly 80% of its tile cladding had deteriorated [15]. In response, Russian imperial engineers undertook emergency shoring work around 1875, most notably rebuilding the collapsed western minaret of the Ulugh Beg Madrasa and re-leveling parts of the square to ensure structural stability [15], [13].

Transitioning into the early Soviet period, the heritage authorities assumed oversight of Registan. A key milestone occurred with the restoration works of Ulugh Beg Madras (1417–1420), the oldest surviving monument on the square. The northern and southern facades of it were piles of rubble at the beginning of the 20th century, as testified by the photographs of Friedrich Sarre, published in 1901 (Fig.1) [12].



*Fig.1. The Ulugh Beg madrasa before 1910 (photograph by Friedrich Sarre, *Denkmäler persischer Baukunst*)*

Thus, its entire courtyard had to be rebuilt and the epigraphic program designed anew. The characteristic hauz (water tank) to the southeast was destroyed. One of the western minarets collapsed in 1870. In the autumn of 1918 it was noticed that the northeastern minaret of the Registan façade had started to tilt. As a result, a lot of engineering effort went into the straightening of the original minarets along the Registan. The first reconstruction project was initiated in 1920 by Mikhail F. Mauer, the chief architect of Samarqand since 1917 [10]. After a decade of preparations, the northeastern minaret was straightened in 1932 by the Moscow engineer Vladimir G. Shukhov, using innovative but masonry-sensitive techniques, a feat he later replicated for the southeastern minaret in 1965 (Fig.2) [12].

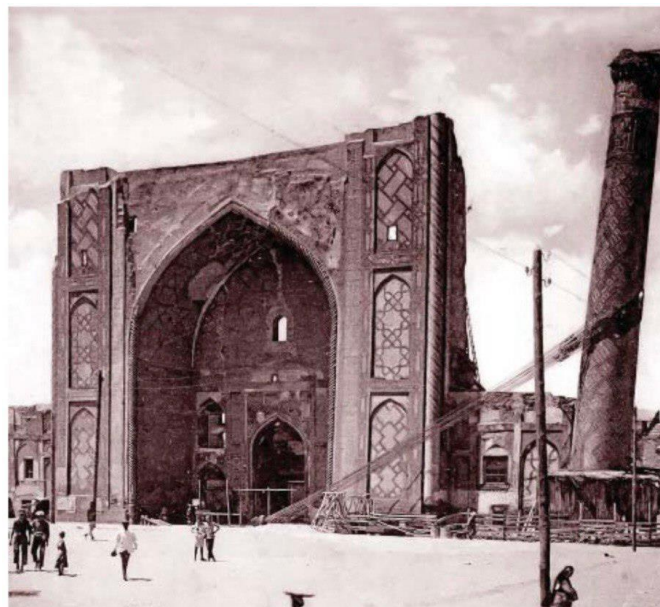


Fig.2. The straightening of the northeastern minaret of the Ulugh Beg madrasa in 1932

In the 1950s E. O. Nelle produced the drawings for the straightening of the southeastern minaret, the work was executed by the engineer E. M. Gendel in 1965. Earlier, in 1925, Boris N. Zasytkin led a restoration of Sher Dor's façade that prioritized conservation ethics, using original brick and alabaster and working with local craftsmen, in stark contrast to later Soviet reconstruction methods reliant on modern materials [13].

The most ambitious phase followed between 1967 and 1987, largely funded by Moscow and completed with support from local authorities. Engineers and archaeologists performed extensive structural and archaeological surveys, recovering reusable original materials for both interiors and exteriors. The dome of Tilla Kori, destroyed since the early 19th century, was reconstructed and its gilded interior was restored around 1979 (Fig.3) [16], [13]. Facades across all three

madrasas received glazed tile replacements, while reinforced-concrete shells were introduced underneath to enhance seismic resilience. Reflecting on this work, Konstantin Kriukov observed that the façades appeared like “garments” draped over structurally reinforced cores [10].



Fig.3. The Registan in 1969 and 1979, showing the rebuilding of the Tilla Kori madrasa

In 1982, the restored ensemble, blending traditional aesthetics with modern engineering, was formally reopened. Although the scale of the interventions preserved the physical integrity and grandeur of Registan, subsequent conservation discourse has critiqued the approach’s impact on material authenticity and respect for historical stratigraphy, as noted by international charters such as Venice and Nara [7],[9].

In summary, Registan’s conservation history progressed from *urgent stabilization in the late 19th and throughout the 20th centuries*, through *structurally conservative but stylistically careful restoration in the early Soviet era*, to a *comprehensive epoch of reconstruction in the mid-to-late Soviet period*. These stages collectively ensured the site’s survival, but also introduced important debates regarding authenticity, integrity, and the ethical limits of restoration.

3.2. Post-independence and contemporary efforts (1991–present). Following Uzbekistan’s independence in 1991, stewardship of Registan transitioned from Soviet oversight to national custodianship. With the square’s designation as part of a UNESCO World Heritage site in 2001, conservation practice shifted toward globally endorsed standards, integrating advanced technologies and ethical frameworks. Notably, in 2018–2019, a Franco-Uzbek collaboration, including the Lublin University of Technology, employed high-resolution 3D laser scanning to assess structural deformation in domes and to digitally archive decorative façades, providing empirical data to guide restorative interventions [27].



Fig.4. 3D decoration of façades of the Registan Square

Recent funding initiatives have focused on targeted preventive and restorative work. In 2024, the U.S. government allocated a \$500,000 grant toward replicating Timurid patterns and stabilizing

tile mosaics across the madrassas' façades [11]. In parallel, UNESCO and the Aga Khan Trust for Culture spearheaded training programs for Uzbek conservators, focusing on preventive conservation, reversible methods, site management, and public engagement, thereby investing in local capacities and sustainable care [22].

Local institutions have increasingly adopted minimalist interventions guided by strict documentation protocols and authenticity safeguards. For instance, restoration of chromatic domes and conservation of wooden portal frames now follow reversible bonding techniques and non-invasive stabilization, all recorded in detailed condition reports and integrated into Registan's long-term conservation management plan.

While tourism continues to bring pressure to the site, current efforts aim to balance access with preservation through strategic visitor circulation plans, surface protection systems, and educational initiatives that help raise public awareness of the site's cultural significance and vulnerability [23], [11]

3.3. Key conservation challenges facing Registan square. Despite decades of concerted preservation efforts, Registan Square remains subject to numerous and evolving conservation challenges that threaten both its material fabric and its cultural authenticity. Among the most persistent environmental risks are Samarkand's harsh climatic conditions. Situated in a semi-arid continental zone, Registan experiences extreme daily temperature fluctuations, low humidity, and seasonal dust storms, all of which accelerate the deterioration of exposed bricks, glazed tiles, and historic mortars [23]. In particular, thermally induced expansion and contraction cycles produce stress fractures across tile surfaces, leading to delamination and pigment fading. Episodes of rainfall combined with wind-driven dust further exacerbate erosion of the architectural reliefs and domes.

Seismic vulnerability presents another major concern. Located within an active tectonic zone, Registan has historically suffered damage from moderate earthquakes. While Soviet-era interventions introduced reinforced concrete cores within load-bearing structures to mitigate this threat, these rigid insertions often limit future reversibility and pose ethical dilemmas regarding long-term material compatibility [4]. Engineering assessments conducted in the 2010s using 3D laser scanning and geophysical sensors confirmed differential settlement in some madrasa foundations and subsurface voids under high-stress zones, signaling the need for continuous geotechnical monitoring.

Tourism introduces a separate but increasingly urgent category of risk. As Uzbekistan's most visited heritage site, Registan receives high volumes of foot traffic throughout the year. While economically beneficial, uncontrolled visitation can cause gradual abrasion of floor tiles, micro-fracturing of wall surfaces, and temperature increases in enclosed areas, contributing to biological growth and mechanical stress. In response, conservation authorities have implemented protective flooring layers in sensitive interiors and are in the process of finalizing a visitor management plan that includes capacity limits and interpretive signage.

A more complex challenge relates to the historical layering of interventions, particularly those conducted during the Soviet period. Earlier restorations, while structurally effective, often prioritized visual monumentality over strict material authenticity. Extensive use of modern cements, synthetic glazes, and reinforced concrete has created long-term maintenance issues, particularly where these materials have weathered differently from the original Timurid fabric [14]. This has occasionally obscured the distinction between original and reconstructed elements, complicating documentation and raising questions about the site's historical legibility.

Moreover, conservation planning continues to be constrained by resource limitations. Although international organizations such as UNESCO, the World Monuments Fund, and the Aga Khan Trust for Culture have contributed expertise and funding, consistent local financing and specialist training remain limited. This has implications for the frequency and technical quality

of ongoing preventive maintenance, including routine cleaning of façades, monitoring of tile adhesion, and seasonal roof waterproofing.

3.4. Evaluation against international principles. Evaluating the conservation trajectory of Registan Square through the lens of international frameworks such as the Venice Charter (1964), the Nara Document on Authenticity (1994), and the UNESCO Operational Guidelines (2017) reveals both commendable achievements and enduring tensions. These charters provide guiding criteria for assessing authenticity, integrity, reversibility, and stakeholder engagement in heritage conservation.

The principle of *authenticity*, as framed in the Nara Document, extends beyond material substance to include craftsmanship, setting, spirit, and use [9]. Soviet-era reconstructions, particularly between 1967 and 1987, compromised material authenticity by substituting reinforced concrete for original brick cores and re-glazing entire surfaces with modern ceramic tiles [4]. However, these interventions were informed by scientific assessments and served to arrest decay, preserving Registan's form and symbolism for future generations. Post-independence initiatives have increasingly emphasized authenticity in the broader cultural sense, integrating traditional artisanship and vernacular methods in restoration, thereby realigning practice with the Nara framework [22].

Integrity, referring to the completeness and intactness of heritage assets, has been largely preserved. All three madrassas have been structurally stabilized and visually unified, with particular attention to retaining the ensemble's urban coherence and symbolic significance. However, the patchwork of interventions, some well-documented, others less so, necessitates clearer demarcation between original elements and reconstructed components, as recommended by the Venice Charter [7]. Current conservation guidelines in Uzbekistan now require all new works to be both reversible and distinguishable under close inspection, supporting the principle of transparent layering.

Reversibility, a core tenet of modern conservation ethics, is an area of challenge. Many Soviet-era restorations relied on irreversible techniques such as embedding concrete within structural walls or chemically altering original surfaces for durability. These choices, while reflective of the technological norms of the time, pose dilemmas for future conservation. By contrast, current interventions prioritize reversible adhesives, lime-based mortars, and minimally invasive anchoring systems, showing greater compliance with UNESCO's Operational Guidelines [21].

Community engagement has emerged as a significant component in recent years. Public education campaigns, local training programs, and employment of traditional craftsmen reflect the increasing recognition of intangible heritage and social sustainability. The Aga Khan Trust's work in Central Asia, including adjacent projects in Herat and Bukhara, has served as an influential model, combining social development with architectural conservation [1]. The U.S. State Department's 2024 grant of \$500,000 for Registan restoration further illustrates growing international collaboration and trust in Uzbekistan's evolving conservation framework [11].

Conclusion

The conservation history of Registan Square illustrates a dynamic evolution in heritage preservation methods shaped by technological advancements, shifting ideologies, and international influence. From early emergency stabilizations to large-scale Soviet reconstructions and, more recently, to technologically integrated and ethically conscious interventions, each phase reflects its time's prevailing values and capabilities. While Soviet-era efforts secured the site's physical survival, they often compromised material authenticity. In contrast, post-1991 initiatives have prioritized minimal intervention, documentation, and capacity building, aligning more closely with global conservation principles. As conservation continues, sustaining Registan's cultural, structural, and aesthetic integrity will require ongoing interdisciplinary collaboration, community involvement, and adherence to international best practices.

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