



**Historic Cities between Urban Protection and the Exception of Fragile Constructions:
Case Study of the Old City of Annaba**

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Abstract:

The degradation of architectural heritage in historic cities has accelerated due to urbanization and socio-economic pressures, threatening structurally vulnerable buildings. This study investigates conservation challenges in Annaba's Old City (*Place d'Armes*), assesses Algeria's legislative and technical frameworks, including Law 98-04 and Executive Decrees 03-323/324, and proposes integrated strategies for sustainable preservation. Using a qualitative case study based on legal analysis, engineering assessments, and field reports, the research identifies major implementation gaps caused by bureaucratic complexity, limited funding, ownership disputes, and weak institutional coordination. It recommends strengthened governance, improved financing, and integrated conservation policies to enhance heritage protection and long-term urban sustainability.

Keywords: Old Cities, Urban Heritage, Vulnerable Buildings, Urban Protection, Sustainable Preservation, Risk Management.

JEL Classification Codes: R11, R58, H83, Q56, Z18.



1. Introduction

The architectural and urban heritage of historic cities represents the living memory, structural repository, and cultural identity of a nation, crystallizing civilizational, socio-spatial, and economic evolutions across historical epochs. Far from being stagnant physical enclosures, these historical urban fabrics function as complex structural systems reflecting localized building technologies, spatial values, and community dynamics. However, globally and within the Mediterranean basin, these delicate ecosystems face unprecedented existential risk driven by aggressive, unplanned urban expansions, infrastructural over-saturation, and structural neglect.

In the Arab world, historic medinas are invaluable civilizational assets that confront severe vulnerabilities. The degradation of these structures implies not only a material loss but a profound erasure of collective cultural frameworks. Addressing these threats requires moving beyond cosmetic restorative repairs toward comprehensive, legally backed, and technologically advanced urban protection strategies.

In Algeria, despite the establishment of a robust legislative framework—spearheaded by Law No. 98-04 and its subsequent regulatory executive decrees—an expanding gap persists between statutory intent and practical enforcement. The Old City of Annaba, historically designated as "Bouna" or "Place d'Armes," stands as a critical example of this systemic discrepancy. Officially classified as a national "Safeguarded Sector" in 2013, its architectural fabric continues to suffer from continuous degradation, structural failures, and social marginalization, while major restoration initiatives remain largely confined to administrative planning phases.

1.1 Research Problematic

This research addresses the systemic gap between institutional heritage legislation and the physical reality of structural degradation in historic cities, focusing on the following core questions:

1. What are the primary structural, environmental, and socio-administrative challenges that drive the degradation of fragile constructions within the Old City of Annaba?



2. To what extent do current Algerian legislative instruments and technical tools address urban heritage protection, and what factors limit their field execution in Annaba?

3. What integrated technical, financial, and administrative strategies can be deployed to ensure sustainable structural stabilization and urban preservation in the "Place d'Armes" sector?

1.2 Research Objectives

This study aims to achieve three primary objectives:

- ♦ **Deconstruct the Vulnerabilities:** Conduct a multi-criteria diagnostic of the architectural deterioration affecting the fragile structures of the Old City of Annaba.

- ♦ **Evaluate Regulatory Efficacy:** Analyze the active legal instruments governing Algerian cultural property protection to identify implementation bottlenecks.

- ♦ **Formulate a Strategic Framework:** Project actionable, scalable solutions that combine advanced technical restoration methodologies with sustainable financial models and community-driven initiatives.

2. Conceptual Framework of Urban Protection and Contextual Realities

To systematically evaluate the vulnerabilities of historical urban fabrics, it is necessary to establish precise baseline definitions for the architectural, legal, and engineering parameters that govern this domain.

2.1 Architectural Urban Heritage

Urban heritage encompasses the entirety of a historical urban ecosystem, integrating structural configurations, public spatial domains, historical infrastructure networks, and the intangible cultural practices embedded within the built environment. It is scientifically categorized as a non-renewable socio-economic asset and a physical archive that reflects the technological, environmental, and socio-spatial breakthroughs of past civilizations.



2.2 Fragile and Vulnerable Constructions

In structural engineering and urban conservation, fragile constructions denote historical buildings exhibiting compromised mechanical integrity, diminished load-bearing capacity, or immediate collapse hazards.

This state of advanced vulnerability is typically induced by material fatigue, environmental weathering, sustained structural neglect, or unregulated, non-engineered user modifications.

2.3 Urban Protection

Urban protection encompasses a comprehensive array of legal mandates, technical protocols, financial mechanisms, and spatial zoning restrictions designed to safeguard the structural authenticity, structural safety, and historical value of designated fabrics. This includes the enforcement of buffer zone building regulations, strict architectural compliance codes, and permanent protection planning guidelines.

2.4 Sustainable Development in Conservation

In historic preservation, sustainability dictates a balanced operational equilibrium between strict architectural conservation and modern socio-economic revitalization. This approach requires that urban fabrics satisfy contemporary economic demands without compromising structural authenticity or historical integrity.

2.5 Regional Realities: The Arab Context

Historic centers across the Arab region face shared threats due to rapid concrete-centric development, high demographic densities, and shifting residency patterns. As original populations migrate to modern districts, historic structures are frequently reoccupied by low-income tenants or transient populations who lack the financial capacity or legal mandate to perform critical structural upkeep.

This socio-spatial trend is evident in the Old City of Sana'a, where unauthorized commercial conversions have dismantled primary internal load-bearing walls, triggering structural failures during intense seasonal rains. Similarly, the historic core of Tripoli, Libya, exhibits severe degradation caused by high demographic density, absent municipal maintenance, and improper interventions

using modern Portland cement, which is chemically and mechanically incompatible with traditional porous limestone and earthen masonry.

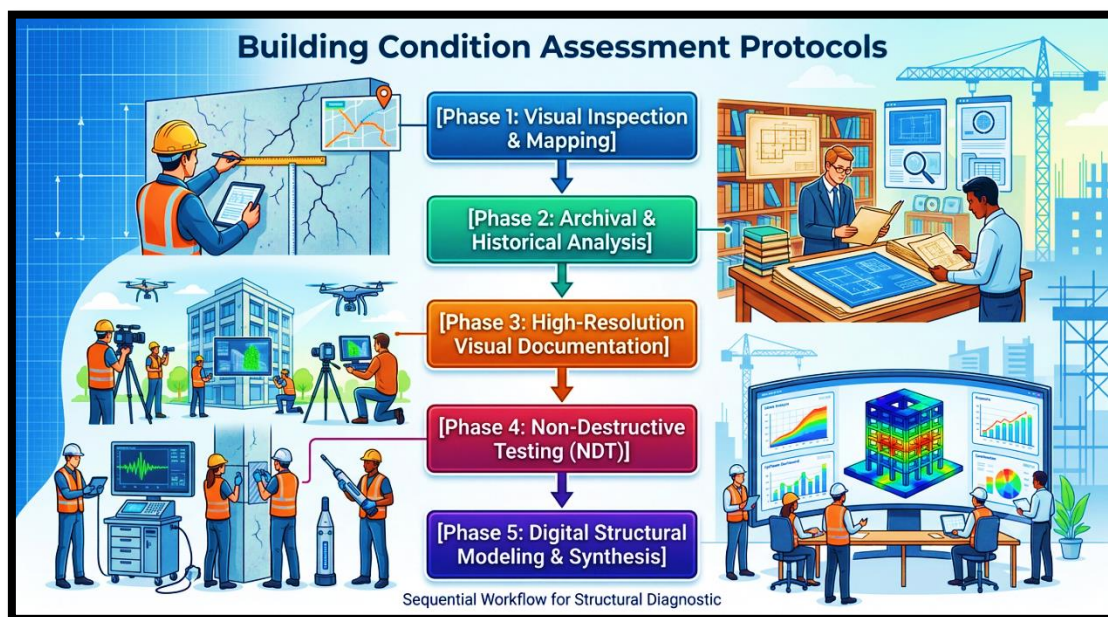
3. Technical Methodologies in Heritage Protection and Risk Management

Halting the deterioration of historical urban fabrics requires transitioning from reactive, ad-hoc repairs to standardized, non-destructive diagnostic workflows and predictive risk assessment protocols.

3.1 Building Condition Assessment Protocols

The execution of a rigorous structural diagnostic follows a precise, sequential engineering workflow:

Figure 1: Building Condition Assessment Protocols



Source: Established by the researchers based on structural evaluation protocols (American Concrete Institute [ACI], 1994; International Organization for Standardization [ISO], 2001).

♦ **Visual Inspection & Preliminary Mapping:** Macroscopic documentation of visible structural anomalies, including active cracking patterns, foundation settlement, masonry displacement, and structural tilting.



♦ **Archival & Historical Analysis:** Compilation of historical engineering records, original construction phases, and prior modifications to map structural changes over time.

♦ **High-Resolution Visual Documentation:** Systematic mapping of localized surface weathering, efflorescence, sub-florescence, and moisture migration profiles across both internal and external structural elements.

♦ **Non-Destructive Testing (NDT):** Deploying ultrasonic pulse velocity, sclerometric tests, and thermographic imaging to isolate hidden structural voids, internal delamination, and moisture plumes without altering the historical material.

♦ **Synthesis & Structural Modeling:** Integrating empirical testing data into analytical frameworks to determine residual load capacities and design tailored conservation interventions.

3.2 The ICCROM Disaster Risk Management Matrix

Predictive risk management shifts heritage conservation from reactive intervention to proactive preservation. Utilizing the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) standards, historic sites are evaluated via a dual-axis matrix that cross-references the probability of catastrophic occurrences against the severity of structural impacts.

This diagnostic evaluates threats across the "Ten Agents of Deterioration" (including chemical pollution, water infiltration, seismic threats, and direct human vandalism) via the "ABC" scale to systematically prioritize emergency budgeting and physical stabilization.

3.3 Advanced Digital Interventions: TLS, FEM, and AI

Modern conservation science leverages advanced digital technologies to improve diagnostic precision and restoration outcomes:

‣ **Terrestrial Laser Scanning (TLS):** Captures ultra-high-resolution spatial point clouds to generate three-dimensional geometric twins of historic buildings, capturing structural deformations, micro-cracks, and structural inclinations with millimeter accuracy.



‣ **Finite Element Method (FEM) Modeling:** Converts TLS geometric data into structural models to simulate dynamic seismic loads and stress concentrations, allowing engineers to predict failure zones prior to physical interventions.

‣ **Artificial Intelligence (AI) Algorithms:** Automated processing of drone-captured orthophotos to identify, map, and classify masonry cracking patterns, tracking deterioration rates over time.

‣ **Compatible Structural Materials:** Utilizing low-modulus lime mortars, natural pozzolans, and breathable geo-polymers that match the vapor permeability and mechanical flexibility of historic masonry, preventing the structural fracturing often caused by rigid cement modifications.

4. The Algerian Legislative and Institutional Framework

Algeria has developed a robust legal architecture designed to protect tangible and intangible cultural assets. However, the operational efficiency of these statutes faces significant execution challenges in complex urban environments.

4.1 Law No. 98-04: The Core Legislative Mandate

Promulgated on June 15, 1998, Law No. 98-04 serves as the foundational text for national cultural heritage protection. This law expanded the scope of Algerian preservation from individual monument protection to the holistic conservation of integrated urban ensembles via the designation of "Safeguarded Sectors" (*Secteurs Sauvegardés*).

Under Article 43, once an urban area is declared a Safeguarded Sector, the municipality must institute a Permanent Plan for Protection and Valorization (*Plan Permanent de Sauvegarde et de Mise en Valeur* – "**PPSP**"). This plan holds supreme legal authority over standard urban planning tools, effectively freezing and replacing standard land-use plans (*Plan d'Occupation des Sols* – "**POS**") to prevent aggressive commercial redevelopment, land speculation, and unauthorized demolitions within the historic perimeter.

4.2 Executive Decrees 03-323 and 03-324

- **Executive Decree No. 03-323 (October 5, 2003):** Regulates the preparation and implementation of protection and optimization plans for archaeological zones and their immediate peripheral buffer zones,



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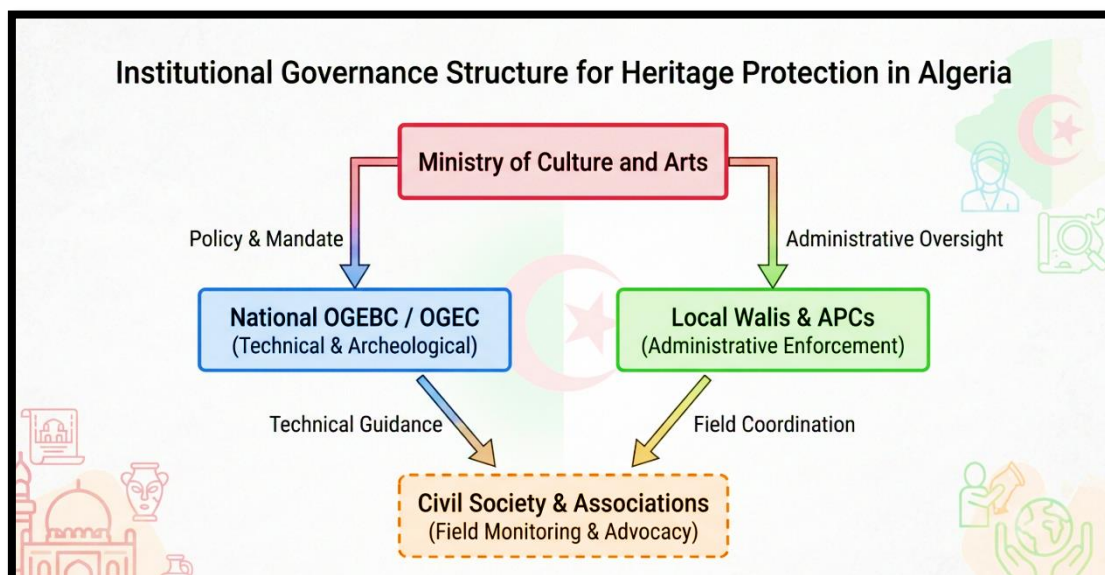
establishing strict structural servitudes to prevent visual pollution and un-engineered structural interventions.

- **Executive Decree No. 03-324 (October 5, 2003):** Defines the operational protocols for creating the “**PPSP**”. It establishes structural parameters for land utilization, enforces specialized architectural profiles for restoration materials, and prohibits the division or structural modification of listed historical real estate without a verified permit from the Ministry of Culture and Arts.

4.3 Institutional Governance and Fiscal Mechanisms

The execution of these legal mandates is managed by a multi-tiered administrative structure:

Figure 2: Institutional Governance Structure for Heritage Protection in Algeria



Source: Designed by the researchers based on Algerian Law 98-04 and Executive Decrees 03-323/324.

Financing for these initiatives is structurally routed through the National Cultural Heritage Fund (*Fonds National du Patrimoine Culturel*), which is designed to underwrite the high costs of specialized structural restoration and



provide immediate emergency funding to stabilize critically endangered urban zones.

5. Case Study — The Old City of Annaba ("Place d'Armes")

The Old City of Annaba offers a clear case study for examining the operational challenges that arise when applying theoretical legal frameworks to deteriorating historical structures.

5.1 Historical Trajectory and Morphological Evolution

Annaba possesses a rich urban history extending over two millennia, originating from the ancient maritime settlement of *Hippone*. Archaeological excavations at Hippone have uncovered a complex urban fabric featuring a Roman theater, extensive public forum configurations, the Northern Baths, and early Christian quarters. Following the Islamic conquests, the urban center shifted northward, establishing a fortified medieval medina ("Bouna") during the Aghlabid and Fatimid eras. During the Ottoman period, the city developed a high-density traditional urban fabric characterized by zero-property-line residential vernacular architecture, narrow winding alleys (*sabats*), and central courtyard houses.

A major structural rupture occurred during the French colonial occupation starting in 1832. The colonial administration executed extensive demolitions within the traditional core, dismantling medieval defensive walls and clearing traditional quarters to build wide, regular military boulevards and European-style neoclassic facades. The historic center, renamed "Place d'Armes," was re-engineered into a military staging ground and arms depot. This intervention disrupted the spatial logic and structural continuity of the original medina, initiating a long-term process of morphological fragmentation.

Table 1: Historical Epochs and Morphological Evolution of the Old City of Annaba

Historical Epoch	Core Morphological Attributes	Long-Term Engineering & Heritage Impact
Ancient Hippone	Fortified maritime core, Roman theater, residential quarters, monumental cisterns.	Establishes the primary subterranean archaeological substratum of the region.
Ottoman Period	High-density Islamic medina, defensive perimeter walls,	Forms the primary spatial and architectural matrix of the



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	stone-and-lime masonry.	modern "Place d'Armes".
French Colonial Era (1832+)	Selective structural demolition, insertion of wide grid boulevards, facade transformations.	Causes morphological fragmentation and compromises the structural continuity of traditional masonry systems.
Post-Independence Era	High demographic influx, absent maintenance protocols, ad-hoc structural modifications.	Accelerated physical degradation, extensive structural water damage, and widespread structural instability.

Source: Designed by the researchers based on historical archives, OGEBC technical reports and Lachraf (2017).

5.2 Empirical Diagnosis of Current Structural Degradation

The Old City of Annaba was officially designated a national "Safeguarded Sector" by executive decree on May 6, 2013. Despite this classification, the site exhibits advanced structural degradation. Under the technical protocols of the National Building Control Laboratory (*Contrôle Technique de la Construction* – "**CTC**"), structural status is categorized using a localized color-coded risk scale:

Table 2: Structural Control Laboratory ("**CTC**") Risk Classification Matrix for Historic Vulnerable Buildings

Technical Risk Category	Mechanical Indicators & Structural Performance	Mandated Emergency Interventions	Est. Urban Volumetric Presence
Green Class	Intact load-bearing masonry, minor cosmetic stucco cracks, stable foundation systems.	Routine preventive maintenance and monitoring.	Limited to highly visible restored religious and public structures.
Orange Class	Deep structural cracking across shear walls, decayed timber floor joists, localized roof collapses.	Immediate structural shoring, installation of tie-rods, and detailed seismic re-engineering.	Encompasses thousands of residential units affected by continuous water infiltration.
Red Class	Severe foundation settlement, pronounced wall tilting, systemic	Immediate administrative evacuation of inhabitants, exclusion fencing, and	Approximately 97,000 buildings nationwide, with a heavy



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	failure of primary columns.	structural stabilization or controlled disassembly.	concentration in old maritime medinas.
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Source: Adapted by the researchers based on Algerian Building Control Laboratory ("*CTC*") technical guidelines and field diagnostic indicators.

This material degradation is exacerbated by complex socio-spatial issues. The "Place d'Armes," which served as a crucial urban stronghold and sanctuary for independence fighters during the Algerian Revolution, has experienced significant disinvestment and social marginalization. The migration of long-term families to modern suburban areas led to the subdivision of traditional homes, which were then rented to low-income tenants without clear legal tenure.

This split between building occupancy and ownership has undermined regular maintenance, transforming important historical structures like the Ottoman-era *Dar El Khodja* and buildings near the old military prison into highly vulnerable structures at risk of collapse.

5.3 Field Interventions and Institutional Bottlenecks

Technical assessments managed by the Wilaya of Annaba have evaluated over 11,000 historical structures, leading to a planned intervention framework for 2,400 vulnerable buildings within the "Place d'Armes" under national urban renewal programs. To support these initiatives, the regional office for monument protection (*Office Regional de Gestion et d'Exploitation des Biens Culturels - OGCRAVA*) allocated a capital budget of 13 billion centimes to stabilize Ottoman-era foundations and contracted international conservation firms to complete preliminary engineering studies.

On a community level, civil society organizations, such as the *Association de Sauvegarde de la Médina d'Annaba*, have initiated localized restoration and alignment efforts.

Working alongside faculty and graduate architects from Badji Mokhtar University, these projects focus on preserving traditional facades and documenting decorative elements. A key milestone of this collaborative approach was the successful restoration of the historic *Sidi Bou Merouane Mosque*, which reopened as a regional cultural and religious center after a precise five-year structural conservation project.



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However, broad-scale structural stabilization across the medina remains delayed by significant operational bottlenecks. The majority of planned interventions have stalled due to administrative delays, including a temporary suspension of specific historic housing funds by the Ministry of Housing. This issue is further complicated by complex co-ownership disputes, unresolved *waqf* (endowment) property claims, and protracted bureaucratic processes required to secure specialized permits for historical structures.

A comparative analysis reveals a core operational conflict: while Algeria's heritage protection laws are conceptually advanced, the formal “**PPSP**” for the Old City of Annaba has faced implementation delays. In the absence of an operational “**PPSP**”, unregulated construction has continued, with some property owners adding multi-story concrete frames onto historic stone foundations. These modifications create significant eccentric structural loads that accelerate foundation settlement and threaten adjacent, interconnected historical structures.

6. Conclusion

The study concludes that safeguarding historical urban ecosystems like the Old City of Annaba requires moving past reactive structural repairs and purely administrative designations. Legally declaring a historic core as a protected sector cannot prevent physical decay without active enforcement tools and dedicated funding pipelines.

To preserve these vulnerable urban landscapes, cities must adopt proactive, technology-driven approaches—such as “**GIS**”-driven structural risk mapping and non-destructive engineering testing—while establishing integrated, inter-ministerial taskforces. Ultimately, sustainable preservation depends on transforming historic architecture from a financial liability into a socio-economic asset. This can be achieved by integrating heritage preservation into broader urban development plans, introducing private tax incentives, and actively involving the local community.

6.1 Key Findings

✓ **The Statutory-Operational Rift:** There is a significant gap between Algeria's advanced cultural protection legislation (such as Law No. 98-04) and its practical application. While the "Place d'Armes" was designated a national



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Safeguarded Sector in 2013, the critical Permanent Plan for Protection and Valorization (*PPSP*) has faced implementation delays, leaving the historic fabric vulnerable.

✓ **Compounded Structural and Environmental Vulnerabilities:** The physical degradation of fragile structures is driven by a combination of environmental factors (moisture, coastal winds, flooding) and unauthorized, non-engineered human modifications. Adding modern concrete frames onto traditional stone-and-lime masonry creates severe load imbalances that threaten connected historical rows.

✓ **Socio-Spatial Shifts and Asset Devaluation:** The migration of original families out of the medina has led to unstructured sub-tenancy arrangements. This loss of community attachment, combined with complex co-ownership disputes and unresolved *waqf* properties, has led to property neglect, turning historic areas into vulnerable physical and social spaces.

✓ **Fragmented Governance and Financial Bottlenecks:** Restoration initiatives are slowed down by complex bureaucracy and a lack of integrated execution between the Ministry of Culture, the Ministry of Housing, and local municipal councils. Furthermore, relying entirely on public funding is unsustainable, highlighting the need for structured public-private partnerships (*PPP*) and clear economic feasibility studies.

6.2 Technical and Policy Recommendations

To resolve the systemic issues stalling the preservation of the Old City of Annaba, this study proposes an integrated framework across five operational domains:

Figure 3: Integrated structural and policy strategies for sustainable preservation

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Source: Designed by the researchers as a comprehensive preservation framework for the Old City of Annaba.

1. Immediate Legal and Administrative Enforcement

- ♦ **Enact the Permanent Protection Plan (“PPSP”)**: Streamline the final review and legal enforcement of the “PPSP” for the Old City of Annaba to immediately supersede standard land-use plans (“POS”).
- ♦ **Enforce Strict Zoning Penalties**: Apply the legal sanctions defined in Law No. 98-04 to immediately halt unauthorized concrete additions and non-engineered structural alterations within the historic core.
- ♦ **Resolve Multi-Ownership and Waqf Impasses**: Establish a dedicated municipal arbitration tribunal to resolve complex multi-inheritance and *waqf* property disputes, granting temporary maintenance mandates to municipal authorities for critical stabilization work.

2. GIS-Driven Structural Risk Mapping

- ♦ **Develop a Unified Heritage Database**: Build an interactive Geographic Information Systems (“GIS”) platform to map structural risks across the medina, updating color-coded safety classifications with real-time field data.
- ♦ **Implement Autonomous Crack Tracking**: Deploy regular drone-based photogrammetric surveys to track micro-fissure expansion rates on vulnerable masonry facades, using predictive modeling to anticipate structural failure points.



3. Advanced Technology Deployment and Material Compatibility

- ♦ **Utilize Non-Destructive Testing (NDT):** Mandate the use of ultrasonic and thermographic diagnostics prior to designing stabilization plans to prevent damaging original building components.

- ♦ **Standardize Permeable Lime-Based Materials:** Prohibit Portland cement modifications on load-bearing walls, replacing them with natural hydraulic lime (“**NHL**”) mortars and lightweight carbon-fiber-reinforced polymer (“**CFRP**”) mesh for adaptive seismic retrofitting.

4. Financial Diversification and Public-Private Partnerships

- ♦ **Implement Public-Private Partnership (PPP) Models:** Design structured investment frameworks that offer long-term commercial concessions to private investors who fund the comprehensive structural restoration of adaptive-reuse historic buildings.

- ♦ **Introduce Targeted Tax Incentives:** Provide municipal property tax exemptions and customs relief on imported specialized restoration components for property owners who complete verified, engineered structural preservation.

5. Inter-Ministerial Institutional Integration

- ♦ **Establish a Unified Heritage Taskforce:** Create a single, cross-functional governing authority with representatives from the Ministry of Culture and Arts, the Ministry of Housing, Urban Planning and the City, and local municipal councils to eliminate bureaucratic overlap and expedite project execution.

- ♦ **Optimize Fund Allocation Pipelines:** Streamline allocation protocols within the National Cultural Heritage Fund to ensure emergency stabilization financing is delivered directly to active structural stabilization projects.

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