

## CUT STONE REHABILITATION - SUSTAINABILITY VECTOR OF OFFICIAL COLONIAL ARCHITECTURE IN ALGERIA: CASE OF SOUK-AHRAS CITY HALL

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### Abstract

*Over time, the building materials used in colonial constructions have undergone various physical, mechanical deterioration and biological degradation. These alterations may be due to human action or due to lack of maintenance on one hand, and inappropriate extensions to the entire original structure on the other hand. Natural risks (earthquakes), climatic hazards (rain, snow, wind, etc.) and the high humidity levels that characterize coastal areas also contribute to the deterioration of these buildings and threaten their sustainability. Cut stone presents specific pathologies due to physical, chemical and biological aggression; all these alterations affect the stone material, requiring its replacement, repair or reconstruction if necessary. This study aims to examine how the rehabilitation of the cut stone facades of Souk-Ahras City Hall can be a contribution to the preservation of a colonial heritage with undeniable values. While it is true that the diagnosis is inevitable before any intervention, it depends on a thorough knowledge of the different pathologies and disorders that threaten the construction. Therefore, the pathologies likely to affect cut stone constructions were first examined, followed by the various interventions to address them.*

**Keywords:** Colonial period; City hall; Rehabilitation; Souk-Ahras Town; Architectural heritage; 19<sup>th</sup> century; Cut stone: pathologies

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### Introduction

The management of the architectural heritage of the 19<sup>th</sup> and 20<sup>th</sup> centuries in its various aspects through rehabilitation studies and the willingness to preserve it, therefore redefines the value given to the latter. Furthermore, it is the testimony of a culture and know-how that is often considered as others, material and intellectual witness of the collective past that characterizes a period, a culture and even a nation. On the other hand, it contributes to studies and research work on the preservation and enhancement of colonial architecture through its construction system and the materials used and the various investigations into the history of art in a colonized territory [1, 2]

In response to the alarming situation, which causes irreversible losses of architectural heritage, international organizations have considered that a significant number of charters and conventions must be drafted to ensure the conservation and sustainability of heritage properties under the prism of rehabilitation and restoration operations, thus establishing a set of measures necessary for their conservation and coherent development and their harmonious adaptation to contemporary life. The Athens Charter for the Restoration of Historic Monuments (1931) [3],

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which sets out the general principles and doctrines for the protection of monuments, provides an overview of conservation materials and techniques. The Venice Charter (1964) aims to promote a spiritual message from the past and considers heritage as a common good to be preserved to ensure its rich and genuine transmission [4]. The International Charter on the Conservation of Historic Towns and Urban Areas (Washington Charter, 1987) concerns more specifically large or small cities and historic centers or districts, with their natural or built environment, which, in addition to being a historical document, express the values specific to traditional urban civilizations [5].

In terms of methodology, the Rehabi-Med Project emphasizes the need to apply the guidelines and recommendations of the guide as part of the overall rehabilitation method, which defines common and coherent intervention criteria to deal with the complex problems that these situations entail. Its objective is to strengthen the rehabilitation and maintenance of architecture as a factor of sustainable development (social, economic and environmental). This method will make it possible to achieve two historical challenges (which are compatible and complementary) [6].

Algeria faces more than two decades of efforts to preserve and enhance its cultural heritage. However, it is not possible to draw definitive conclusions but to present a significant set of facts considered as real “anomalies” recorded at all levels and in the various aspects retained, which are essential for the management of the architectural heritage [7]. The example of the Kasbah of Algiers, which to date, none of the policies and directives designed for it has really succeeded to preserve and integrate it into the day-to-day lives of the population.

There are considerable gaps between the theoretical and practical aspects of heritage policy in Algeria, even after Law 98-04 [8]. The fact that these policies have not been made accessible has only accentuated the situation of certain sites considered as preserved sites, such as the example of the Kasbah of Dellys, which was classified as a national heritage site in 2003. Indeed, to date, all the houses at risk of collapse have not received any assistance, except for a few emergency measures, which consist of aluminum roofs for some buildings, some stirrups and the removal of the stones from the lower Kasbah [9].

However, this paper aims to verify the hypothesis of the rehabilitation technique choice according to a scientific approach while relying on the consultation of a multidisciplinary team that can contribute to the preservation of the Souk-Ahras City Hall and thus promote its sustainability. Then, it is necessary to elaborate a document for the rehabilitation of cut stone, based on knowledge, documentary research and in situ work, through field investigations encompassing the various colonial constructions designed especially during the first years of colonization. This involves rehabilitation with a minimum of rigor, which involves the transfer of its heritage values (historical, artistic and memory) to future generations [10].

Based on knowledge of the materials and their behavior, a discreet intervention is required as much as possible to maintain the authenticity of these constructions, while ensuring their durability over time and space.

Identifying the different pathologies and causes inherent in the degradation of the cut stone of Souk-Ahras City Hall contributes to gain knowledge on the rehabilitation of this material to ensure its durability for the entire range of buildings built with this material since then. The rehabilitation must involve stakeholders that respect the existing heritage and are able to appreciate its intrinsic qualities [11].

## Case study

### *Urban and architectural evolution during colonial period*

During the colonial period, the city of Souk-Ahras underwent profound changes and transformations that would forever mark its various structures (Fig. 1). The city is characterized

by buildings that reflect the image and authority of a colonial regime, including the City Hall of Souk-Ahras.

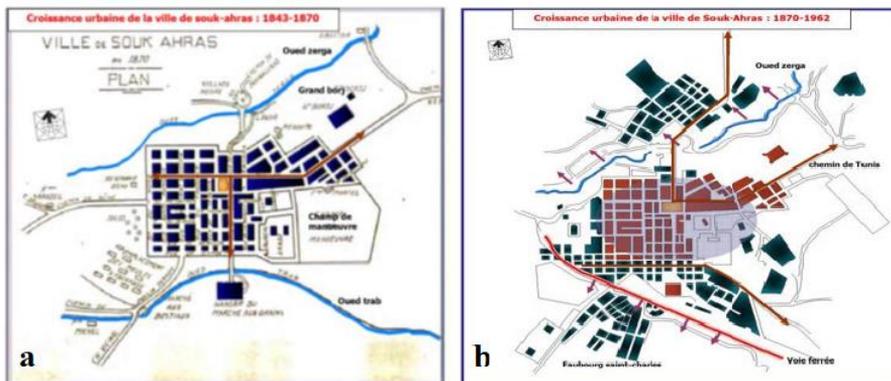


Fig. 1. Urban growth of the city of Souk-Ahras: a - 1843÷1870, b - 1870÷1962 (Source: Land Register ???)

***Souk-Ahras City Hall***

The City Hall of Souk-Ahras is located in the city center, in a dense, typically colonial urban fabric, built in a record time of 15 months. The City Hall was inaugurated in 1887 [12, 13]. Over time, this jovial architecture has become a refuge for the vicissitudes of time (Fig. 2).



Fig. 2. City Hall before and after rehabilitation

***Cut stone as a sustainability vector***

Cut stone is a material used for large-scale projects. It is a natural stone with all its surfaces cut and its visible surface perfectly rectilinear.

In Algeria, the cut stone was the most commonly used by the colonial regime and consisted of sedimentary rocks of several formations (usually limestone sandstone). The limestone sandstone of the Pachna Region was the main source of cut stone. This material is suitable for construction because it consists of hard stone made of small and medium sized particles.

These cut stones are found in quarries located on the eastern side of the town of Souk-Ahras and are used for a wide range of purposes, including load-bearing walls, basement walls, framing openings and pillar construction. This material, through its natural characteristics, is durable and can last for centuries. If it is permanently maintained, all the pathologies that could affect it are controlled. They are distinctive because of their character, originality and invention; they shape the environment and integrate naturally into it [14].

To ensure the sustainability and preservation of Souk-Ahras City Hall, rehabilitation is inevitable. However, this process, which is reliable and constructive, must follow a process known as “the rehabilitation process” (Fig. 3).

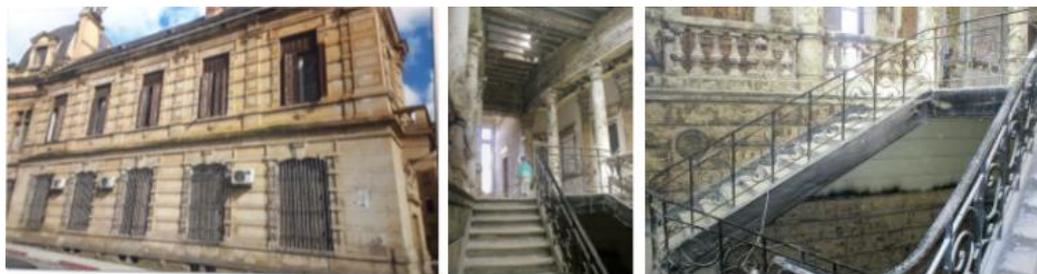


Fig. 3. South-West facade and views of the interior of City Hall

## Materials and methods

To apprehend a rehabilitation operation we can follow ~~four~~ certain phases [15].

*Knowledge:* it is a preliminary phase, composed of a *pre-diagnosis* that provides an initial assessment of the building and its users followed by a multidisciplinary study (analysis) in which the field (social, historical, architectural and constructive) is analyzed; the historical analysis must precede the work' analysis; only in urgent cases can it be justified otherwise [16]. The pre-diagnosis phase in the engineering study of an existing traditional building is probably the most crucial point in the entire task of rehabilitating old buildings [17].

### *Examination of the existing system*

Prior to any cleaning process, it is advisable to assess the condition of the stones to adapt the treatment. Walls made of stone masonry intended to be covered with plaster can thus be distinguished from those made of cut stone masonry intended to be exposed, either on the entire façade or on the ornamental elements such as basements, corner chains, cornices, bay frames, etc.

The identification phase makes it possible to establish an inventory of the components (soft or hard stones, whitewashes, paints, stratigraphic deposits, etc.). Then, it is necessary to carry out an evaluation of the conservation status of each component of the façade (flaking, pulverization, cracks, missing joints, etc.).

### *Cleaning process*

This procedure must be carried out during a non-freezing period. The cleaning must be performed without altering the stone to prevent the destruction of the cullet that protects the surface. The choice of technique (low-pressure water, coconut brush, microgumming, hydrogumming, nebulization, cryogenic process, laser, compresses, peelable films, etc.) must also be chosen according to the preliminary diagnosis.

### *Reflection and project*

Once the building and its users have been identified, the diagnosis is carried out. This is the synthesis of the pre-diagnosis, which identifies the problems and their main causes. Then the reflection and decision-making stage follows, through which a set of hypotheses is

developed. The identification of the nature and origin of any disorders will enrich the study and they will be confirmed or denied during the study [18]. They are based on the promoters' ideas for carrying out the work and their feasibility in accordance with the building's situation, its heritage values and the economic investment opportunities.

#### *Alveolization*

Driven by water, salts crystallize when water evaporates (Fig. 4). They burst the stone and form small craters into cells.



**Fig. 4.** Alveolization on the North Facade

#### *Dissolution*

Protective cullet is dissolved by the action of acid rain on limestone or eliminated as a result of unsuitable refinements (sandblasting, scrubbing, high pressure, etc.) (Fig. 5).



**Fig. 5.** Dissolution on the South East façade

#### *Efflorescence*

Sulphates in the atmosphere and nitrates from groundwater can settle in stones by creating an expansive salt (sulfin) causing them to burst. Lichens can also promote biochemical degradation (Fig. 6).

#### *The rehabilitation project*

This is the transition to *rehabilitation action* with a judicious choice of builders and collaborators for a better quality of execution of the work to ensure that the building will be in good working condition (structurally and functionally) and adapt it to the new requirements of the time. This building can even be renovated [19].

After several tests, *Tradical PF 60*, a pre-formulated binder based on air lime (65%), hydraulic binder (15%) and pozzolanic (20%), mixed with aggregates and mixed with water, was chosen.



Fig. 6. Efflorescence on the Main Entrance

After the diagnosis phase for all the façades and the consultation of the intervention team, the choice was made on 4 interventions, namely:

*Repair of facings and repainting*

When the altered or friable parts of the stone were cleaned and cut back to the healthy part (up to a maximum of 2cm thick), it is recommended to make a levelling of the surface. It is made with a mortar that has the same color and hardness characteristics as the stone, while respecting the original equipment. This mortar prevents the creation of a waterproof barrier (Fig. 7 and Table 1).

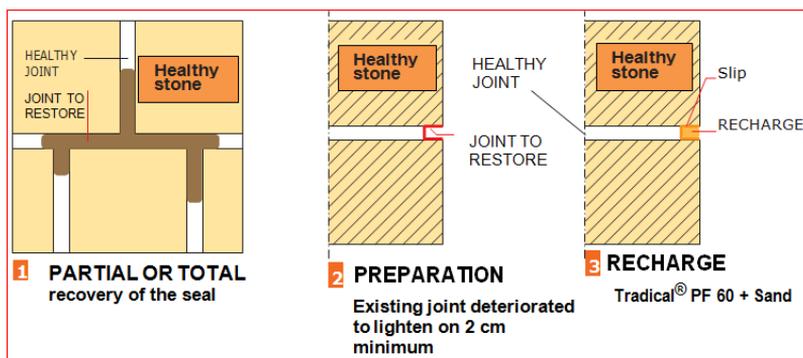


Fig. 7. Repair of the facings and pointing

Table 1. Dosage of repair of the facings and pointing.

TD1					
DOSAGE	Tradical® PF60	Sp* (stone powder) 10 l bucket	Sand 0/2 10 l bucket	Sand 0/4 10 l bucket	Water
Joint in cm	1 bag	3	5 at. 7	6 at. 8	to be adjusted for a transition to a joint pocket

*Punctual repair*

This is a repair set directly applied to the stone (Fig. 8 and Table 2):

1. purge the stone to its healthy part;
2. cut the edge of the part to be repaired back into an undercut;
3. dry dust removal.

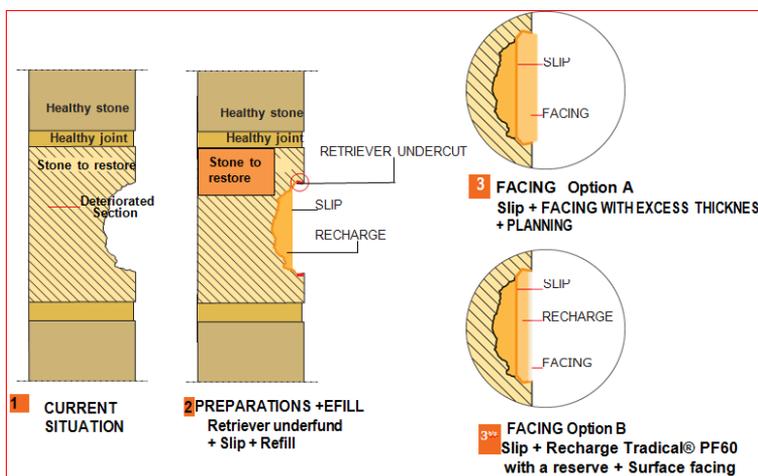


Fig. 8. Punctual repair

Table 2. Dosage of punctual repair.

T D2		STONE		Sand Granular	Water
DOSAGE	Tradical®PF60	HARD Sand 10 l bucket	SOFT Sand 10 l bucket		
Slip	1 liter	/	/	/	To be adjusted according to the application
Recharge	1 Bag	5 at. 7	6 at. 8	0/4	
Facing	1 Bag	4 at. 6	5 at. 7	0/2	
Thin facing	1 Bag	2	3	Sp*	

\* Stone Powder

**Stone siding, repair**

This involves filling the joints and at the same time the stone facing (Fig. 9 and Table 3):

1. purge the stone over its entire surface, keeping a greyish aspect for a better adhesion of the mortar;
2. dry dust removal;
3. in the case of a refill thickness greater than 30 mm, dowel in a 10 to 15cm grid.

**Ornamental treatment, repair**

This involves replacing damaged stones with new ones (Fig. 10 and Table 4):

1. purge the stone over its entire surface, keeping a grey appearance for a better adhesion of the mortar;
2. dry dust removal;
3. installation of a stainless steel dowel system according to a 10 to 15cm grid;
4. moisten the stone (several times in the case of soft to very soft stone);
5. let it to soak;
6. apply Tradical® PF 60 slip to the stone;
7. let it to soak;
8. as it progresses, apply a Tradical® PF 60 adhesive mortar. Allow to dry for two or three days.

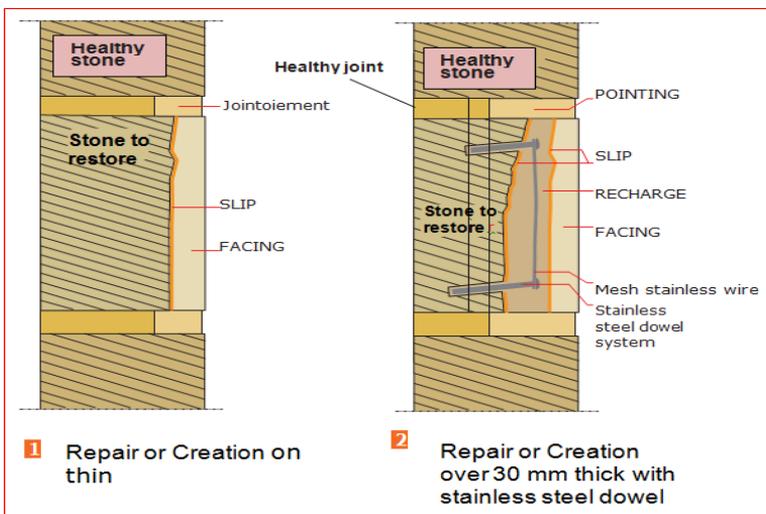


Fig. 9. Stone siding, repair

Table 3. Dosage of stone siding, repair.

T D3		Stone		Sand Granular	Water
DOSAGE	Tradical® PF60	HARD Sand 10 l bucket	SOFT Sand 10 l bucket		
Slip	1 liter	/	/	/	1 liter
Recharge	1 Bag	5 at.7	6 at.8	0/4	To be adjusted according to the application
Facing	1 Bag	4 at.6	5 at.7	0/2	
Thin Facing	1 bag	2	3	Sp*	

Creation: hard stone dosage

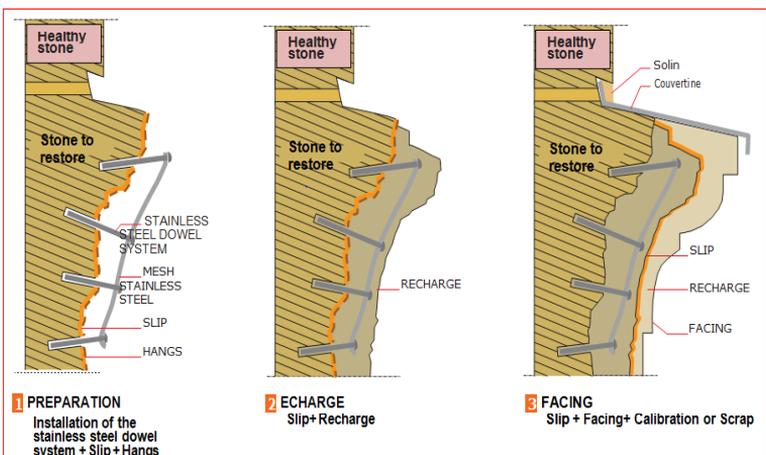


Fig. 10. Ornamental treatment, repair

**Table 4.** Dosage of ornamental treatment, repair.

TD4		Stone		Sand Granular	Water
		HARD	SOFT		
DOSAGE	Tradical® PF60	Sand 10 l bucket	Sand 10 l bucket		
Slip	1 liter	/	/	/	1 liter
Hang	1 Bag	2 at. 2, 5	3 at. 3, 5	0/4	To be adjusted according to the application
Recharge	1 Bag	5 at. 7	6 at. 8	0/4	
Facing	1 Bag	4 at. 6	5 at. 7	0/2	
Thin Facing	1 Bag	2	3	Sp*	
Creation: hard stone				* Stone Powder	

***The maintenance phase***

Maintenance can be carried out just after the pre-diagnosis stage to ensure better conservation of the heritage property or it can come just after rehabilitation work to ensure its sustainability because permanent maintenance remains the first protective measure [20].

**Results and discussion**

This study reviewed the various stages of the rehabilitation process relating to the rehabilitation of the cut stone of the Souk-Ahras City Hall. The use of cut stone on the façade of public buildings from the French Period encourages the of an influential and dominant colonial state's authority [21, 22].

The success of a rehabilitation operation depends on the mobilization of a group of specialists in the field of heritage to stakeholders who respect the existing heritage and are able to appreciate its intrinsic qualities [23].

The cut stone of the Souk-Ahras City Hall contributes to the expression of an official colonial architecture in Algeria, so its rehabilitation was a rather complex task that combined two essential aspects: history and the evolution of art and architecture (style, materials and construction techniques that must be taken into account because the integrity of the building can be threatened) [24]. On the one hand, the choice of rehabilitation techniques, and on the other hand, the values to be preserved, the form and appearance of the buildings (interior and exterior), as defined by their structure, volume, style, scale, materials, color and decoration [25-30].

All joints were made with air lime mortar with or without the addition of stone powder of the same type. The joints were smoothed, not very wide, solid, neither recessed nor protruding, flush with the facing without burrs and sponged.

It is important to note that:

- Cement is a harder material than stone and has to be avoided. Indeed, it does not promote the exchange of water vapor and causes imbalances in the walls. Trapped water causes the stone to freeze and favors surface blooms efflorescence.
- Waterproofing paints and coatings are also not recommended as they reflect moisture back into the building.
- When some ornamental elements, such as frames, were colored with lime and natural pigments, it is recommended to maintain these practices and restore these effects.
- Lime whitewash or patina (more diluted than whitewash) can be used to homogenize bay frames or facings that have been altered by successive repairs.

- Slip: when the work is interrupted, or when the mortar has dried, before continuing the installation, the slip must be reapplied.

## Conclusions

The aim of this cut stone rehabilitation project of Souk-Ahras City Hall was to highlight the importance of the knowledge phase in a rehabilitation study, while using an integrated conservation approach that encourages the involvement of all stakeholders (qualified architects of monuments and sites, engineers, technicians in the restoration and rehabilitation of old buildings, archaeologists and researchers in art history as well as a company in the restoration and rehabilitation of old sites).

The main reasons for this research were based on certain rehabilitation operations applied anarchically to colonial constructions without prior diagnosis of the origin of the pathologies that cause the alteration of this heritage

Finally, the rehabilitation of cut stone must be flexible to provide some innovations without neglecting its overall appearance and originality and to be in line with the changes in human lifestyle.

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