Using Architectural Stratigraphic Surveys to Study Historical Buildings: An Illustration through El Mechouar-Tlemcen, Algeria

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Abstract

Architectural stratigraphic survey inspired from Harris, Brogiolo et Francovich (1982) is a useful technique to study historical buildings especially when there are layers to explore. This research illustrates its use by identifying the micro-history (Filippo, 1994) hidden whether in a centimeter of *Zellige* or a simple scar of masonry in a historical complex in Algeria. What is unearthed could have been rarely found through the simple historical approaches or in the old documents. The technique can help the architects to find cues to develop future restoration projects.

This research investigates the stratigraphy and the physical materiality in the built structures of the historical buildings: at El mechouar-Tlemcen: a historical palimpsest complex. It conveys an image of several modifications, which gives a characteristic of complex mutability. The technique gathers all the historical and technical documentation and allows later to visually note the modifications and the actions carried out. Each stratigraphic unit defines a materiality relative to a masonry that characterizes the historic monument.

The stratigraphic analysis succeeded in re-tracing the historical evolution of the complex, and identifying temporal layers dating from the 14th century to the present day. It thus describes the restoration operations carried out from 2003 to 2010.

Keywords: El Mechouar, historical evolution, stratigraphic survey, restoration operation, Stratigraphic signs, Masonry.

Introduction

The stratigraphic analysis of monuments and buildings which are preserved in height is a system developed "in the 1970s in urban archeology by P. Parker and E. C. Harris" (Edward, 2014a). Then, it was developed in the field of architecture during the 1980s. Nowadays, it is considered an essential technique, which can be applied to any old building. It is a building diagnostic method that enables the study of a building from both a construction point of view and a detailed dating at the masonry scale.

The architectural stratigraphic survey is a recent analytical process, which has not been fully codified yet. There are notable differences, which distinguish the experiments carried out by various researchers. The fundamental element in this analysis is the definition and

identification of "masonry surface units (MSU)" (stampa, 2003). Identifying MSU requires a careful visual analysis of the building and a continuous consultation of historical building data.

Architectural stratigraphic survey was first introduced in the late 1980s by Dogliono and Parenti (Samia, 2016a) who drew the principles from sedimentology. They depended on architectural stratum (masonry) to form a uniform unit which generates scars (imprints or visible signs) corresponding to the different actions and interventions on the building.

In the field of heritage preservation, conservative interventions are needed. It aims at preserving the various historical phases, which characterize the evolution of the monument, and enables a correct historical reading later. This leads to a great refinement of diagnostic methods. However, Algeria for a long time willfully ignored the progress made in this field as the majority of architectural consultants depend on the historical approach. In addition, the Algerian restoration architects have not mastered the diagnostic tools, which are appropriate to a stratigraphic architecture.

The El Mechouar complex is a fortress of three hectares, located in Algeria. It illustrates several historical eras, which have led to modifications, demolitions or new constructions. Those changes are applied to palatial, defensive, religious and cultural buildings. The palace, the mosque and the rampart have witnessed several historical transformations. They include constructive accumulations and rich stratigraphic content, which has not been disclosed yet. The Stratigraphic survey is used as a method to interpret this constructive and evolutionary dynamic over time, which has affected these ancient buildings.

This work reviews the applications of the strategraphic survey. This approach enables us to determine the operational tools. Finally, the study of the Mechouar palace complex illustrates the application of all the tools drawn.

This paper aims at identifying the stratigraphic signs that indicate the historical evolution. The purpose is also to identify whether those signs are capable of providing a true chronological evolution of the El Mechouar complex today.

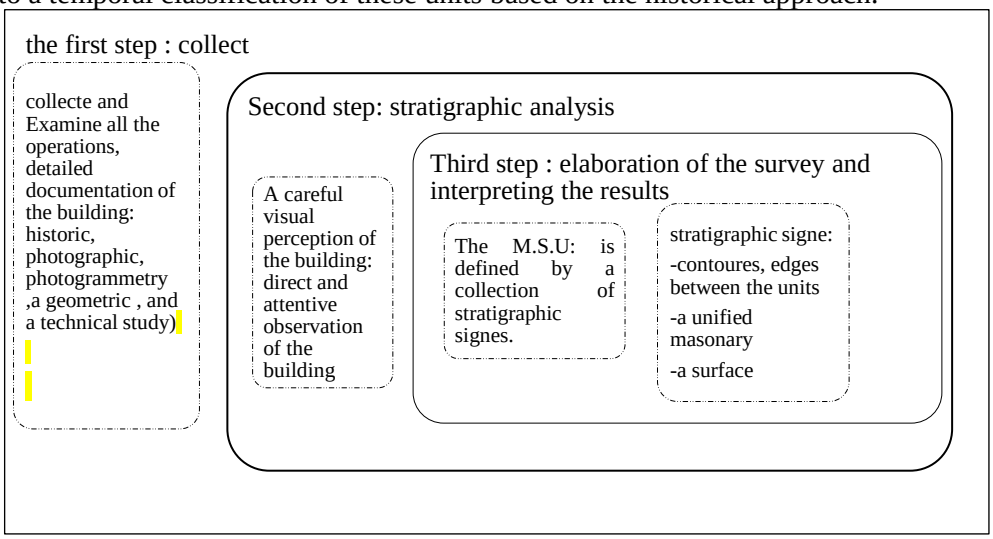
Previous Research and Applications

Harris, Brogiolo and Francovich are considered the fathers of architectural stratigraphy. According to Harris: these principles are the fruit of a relatively recent tradition which reached its peak in "British archeology" (Edward, 2014b). Many (Parenti,1985, 1988; Doglioni & Gabbiani,1985; Doglioni, 1997; Brogiolo, 1988) have conducted several experiences in different research centers (Siena, Genoa, Venice, Brescia then Rome, Milan etc.). Those experiences have applied the stratigraphic survey in elevation and its relation to restoration, whereas, in addition to the stratigraphic survey in elevation, some (Mannoni, 1994; Parenti, 1994; Cagnana, 2000) have revealed the study of techniques of construction (Gian Pietro, 2002,). All those applications are classified as “traditional survey techniques” (Di, et al., 2016a) which require manual graphic and analytical work. However, the second category, which is named “innovative” (Di, et al., 2016b) consists of using new technologies such as “the three-dimensional laser scans” (Bortolotto, et al., 2019). In Algeria, (Samia, 2016b) have only applied the stratigraphic survey in elevations in her work which is a traditional survey of a set of residences.

The Operational Methodology of the Stratigraphic Analysis:

According to Harris, Brogiolo and Francovich (Edward, 2014c), stratigraphic analysis of monuments takes place according to different consecutive phases which can be presented in the scheme below (see scheme.1). The first step includes the collection of all the information related to the history of the building. The second step identifies the masonry stratigraphic units, which were exposed in the building or photogrammetry surveys of the building state before and after intervention. The masonry stratigraphic unit identification is based on the masonry visual

perception which permits the division of stonework into units of scars areas (the contours, edges and boundaries of the different stratigraphic units), corresponding to units of intervention. Then, it resorts to a temporal classification of these units based on the historical approach.



Scheme 1: The operational methodology of the stratigraphic analysis
Source: (Edward, 2014d - schematized by the authors)

The M.S.U. appears completely visible in the external facade of the wall in which it is fragmented or interrupted by other units inside. However, in many cases, it is invisible because the unit is often compromised in the structure of the building. Depending on the degree of the details that can be seen and the configuration of the building, the M.S.U can be a wall or its smallest element as long as it is no longer divisible.

On one hand, there are synchronic stratigraphic surveys, which are related to visual perception. They are used when the eroding walls permit to identify the masonry surface unit, which accumulates traces on this building. On the other hand, there are diachronic stratigraphic surveys, which read the interventions. They are utilized to trace the actions taken for most interventions (before and after) when some restoration operations require the application of coatings or other changes to the stratigraphic signs.

Once completed, the analysis provides a statement containing the development and modification phases of the analyzed building. However, the complexity lies first in the drafting and schematization of the varied results due to the history of the building structure, which can be complex. Second, the complexity also lies in the reading of the survey as well as in the future decisions taken by the architect. It is known that the formation of a stratigraphic unit requires cycles of least activity or pause. As the period of modification narrows, it will be difficult to visually determine the stratigraphic layer without reference to the documents. However, it is impossible to conduct a stratigraphic analysis in the absence of historical references and various reports, which document the changes in the building.

The Stratigraphic Survey Method Adopted: Diachronic and Synchronic Analysis:

We have studied the architectural stratifications of some buildings in this complex, which deserve documentation despite their damaged historical value. In particular, in 2003 and 2010, the various interventions carried throughout nine centuries have been studied. The analysis focuses on the unambiguous exploration of micro-historic masonry so as to improve future practices.

All of the following historical sources have been taken into consideration: archives, books, photos, archaeological excavation reports, plans, photogrammetry surveys, records of pathology and materials developed by the architect A. Chiali (a technical file archived by the Culture Department, Tlemcen). At this stage of analysis, it was necessary to undertake an investigative work in order to identify the different stratigraphic units. In addition to the metric survey, photogrammetric survey, a coding system (numbering) of walls and M.S.U, which consists of a raw material, an MSU inventory sheet (Fig.1) was used as an investigation tool which synthesizes all the historical and constructive characteristics of each stratigraphic unit. This sheet is structured according to a set of information: general data of the analyzed building, and the location. Data describes the dimensions and the constitution of this unit, observations, and dating. Once all the files are systematically analyzed, synchronic and diachronic stratigraphic surveys in the form of plans, sections, and elevations must be prepared.

<table>
<tr><td>Building location : Tlemcen</td><td rowspan="4"> 
A photogrammetry servy : wall (03), source : the Culture Department, Tlemcen</td></tr>
<tr><td>Type of building : remains of a palace before its reconstruct</td></tr>
<tr><td>Building area : 385 m^2</td></tr>
<tr><td>M, S, U number: 07</td></tr>
<tr><td>the nature of the materials / dimensions</td><td>The 18 cm wide brick</td></tr>
<tr><td colspan="2">Location : wall number 03</td></tr>
<tr><td colspan="2">Situation : north</td></tr>
<tr><td colspan="2">wall dimensions (height = 9.1, width = 15.2 / thickness = 0.76)</td></tr>
<tr><td colspan="2">M, S U, Shape : irregular</td></tr>
<tr><td colspan="2">Area of M, S, U = 8.01m2</td></tr>
<tr><td colspan="2">Colour: Brown</td></tr>
<tr><td colspan="2">pathology: vertical crack</td></tr>
<tr><td colspan="2">State of conservation : bad</td></tr>
<tr><td colspan="2">Thickness of the contours of M, S, U:/</td></tr>
<tr><td colspan="2">Observation : the M, S, U appears as a second wall collapsed and superimposed on the old wall</td></tr>
<tr><td rowspan="2">Interpretation</td><td>dating : 18^{th} century</td></tr>
<tr><td>period: French colonization</td></tr>
<tr><td>Date of analysis: in 2021</td><td></td></tr>
</table>

Fig. 1: An Example of a M.S. U. Inventory Sheet Number 07, wall number 03, vestige of the palace, Source: Authors

The El Mechouar Complex:

El mechouar is a citadel, which is a symbol of political power, a testimony of a pre-modern Algerian dynasty, retracing the main features of Zianid architecture. It has a plan of the irregular type reflecting a diverse architecture: medieval and modern.

The geographical location of the citadel of el-mechouar is 34 ° 52 North latitude and 1 ° 18 longitude West. Currently, it is located in the city center of Tlemcen, in Algeria. Its surface area is three hectares. It is limited by two boulevards from North to South: boulevard November 1 and boulevard Inal Ahmed. From the East to the West, it is limited by the popular district R'HIBA and CndFerradj avenue.

Fig. 2: Source: google-earth online; 2021

Results and Discussion

a) The Royal Palace Rebuilt in 2010

The historian Georges Marçais in his work "famous art cities: Tlemcen" (Georges, 1950a), have dealt with the period of 1318-1336 under the reign of Abu Tachfin 1st Ben Hamou Moussa. During this period, the El Mechouar palace was embellished. In addition, three palaces around this palace including the royal palace (*Dar El Moulouk*), the Abu Fihr palace (*Dar Abou Fihr*), and the hostelry of joy (*Dar Es Sourour*) were erected by Yaghmouracen Ben Zianeen in 1235.

"In 1990, […] medieval remains have been found" (Khelifa, 2011). It was one of the four Zianides palaces, which also appeared on an underlying level of the so-called Manutention barracks during demolition. They have found traces of construction and older stratifications dating back to the period of the Ottoman and the French. It was believed that they build and modify the structure of one of the ancient Zianide palaces. Later, remarkable results were obtained in 2009 during an archaeological excavation. It is about a "cooperation mission developed in Tlemcen in the field of archaeology which associated two Algerian entities […] with various French partners" (Charpentier, et al., 2011, p. 55).

The palace consists of a number of rooms, which are located throughout four sides of a large patio (Fig.3). They are large multifunctional rooms and anterooms. "This common characteristic has been denoted by Georges Marçais between the case study (the Mechouar) and the small Partal Palace (the Alhambra)" (Kasmi & Aiche, 2016).

The rooms and the patio are generally paved with *Zellige* dating back to the 12th century. The spatial organization around the patio reflects the socio-cultural values of Moorish architecture. The rooms and the patio are also paved with an obligatory passage and a control space. A symmetrical composition spreads progressively from the East to the West, interrupted by a single-family house with a patio, which was developed at the northern limit. According to the conclusions drawn from the report by the National Archaeological Research Centre (CNRA) in 2010, the single-family house was dated back to the 14th century. It is characterized by reduced dimensions, pieces of 4.75 * 4 meters, which are considered less noble. The excavations also showed a passage and secret underground chambers used to ensure the escape of the king during the attacks.

The stratigraphic survey (see Fig.4) has revealed a masonry, which is characterized by a general use of cob walls dating back to the 13th -14th centuries, an average height from 1 to 2 floors. It has been noted that the tuff stones dating back to the 17th century have replaced the

damaged cob. It also indicates the fall of the wall covering and ornaments. This period marks a reuse of the old walls, which have witnessed a time of abundance. The destroyed place has been reconstructed after the uprising of the parish in ‘’1670’’ (Quetin, 1848) by Bey Hassan who won the war.

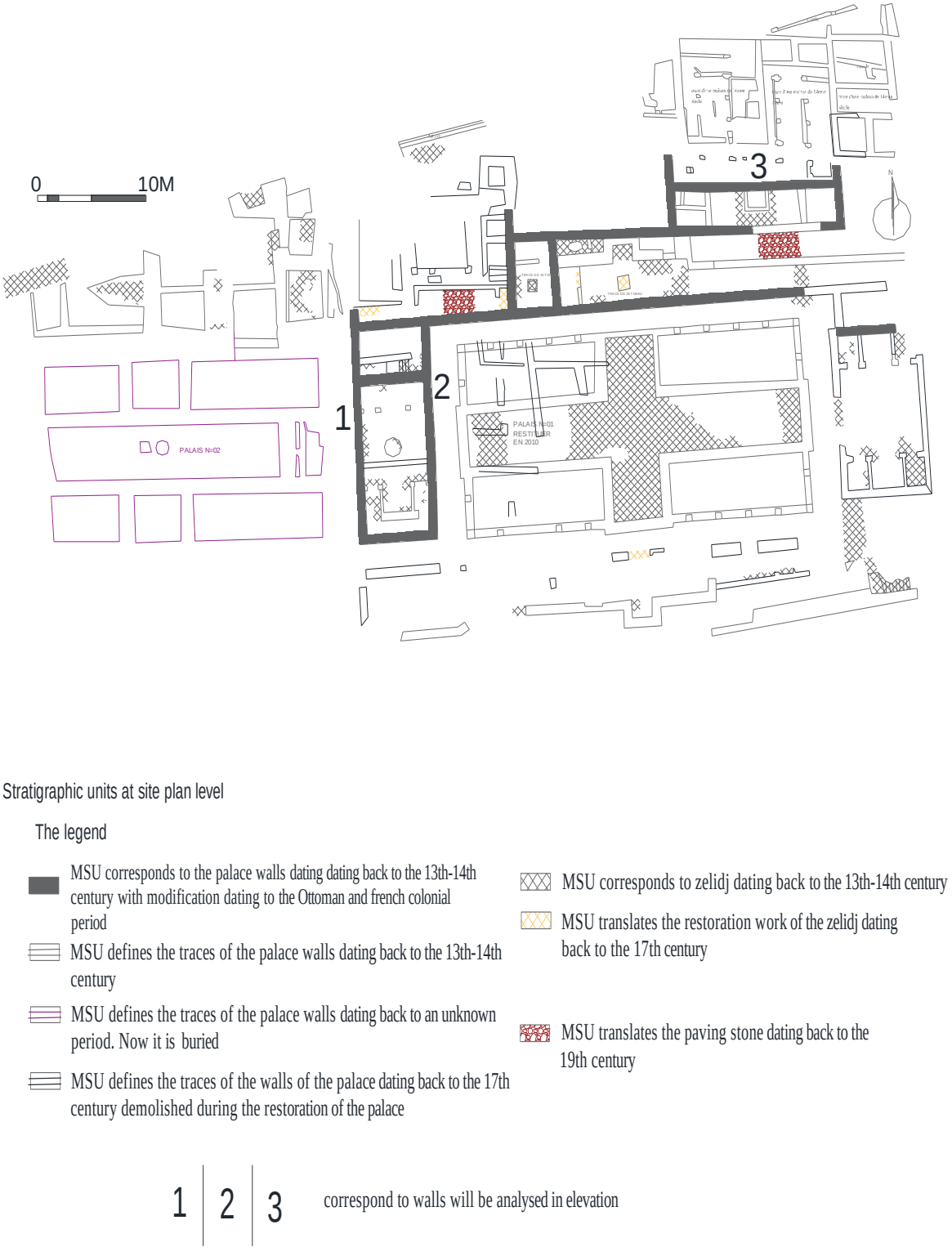
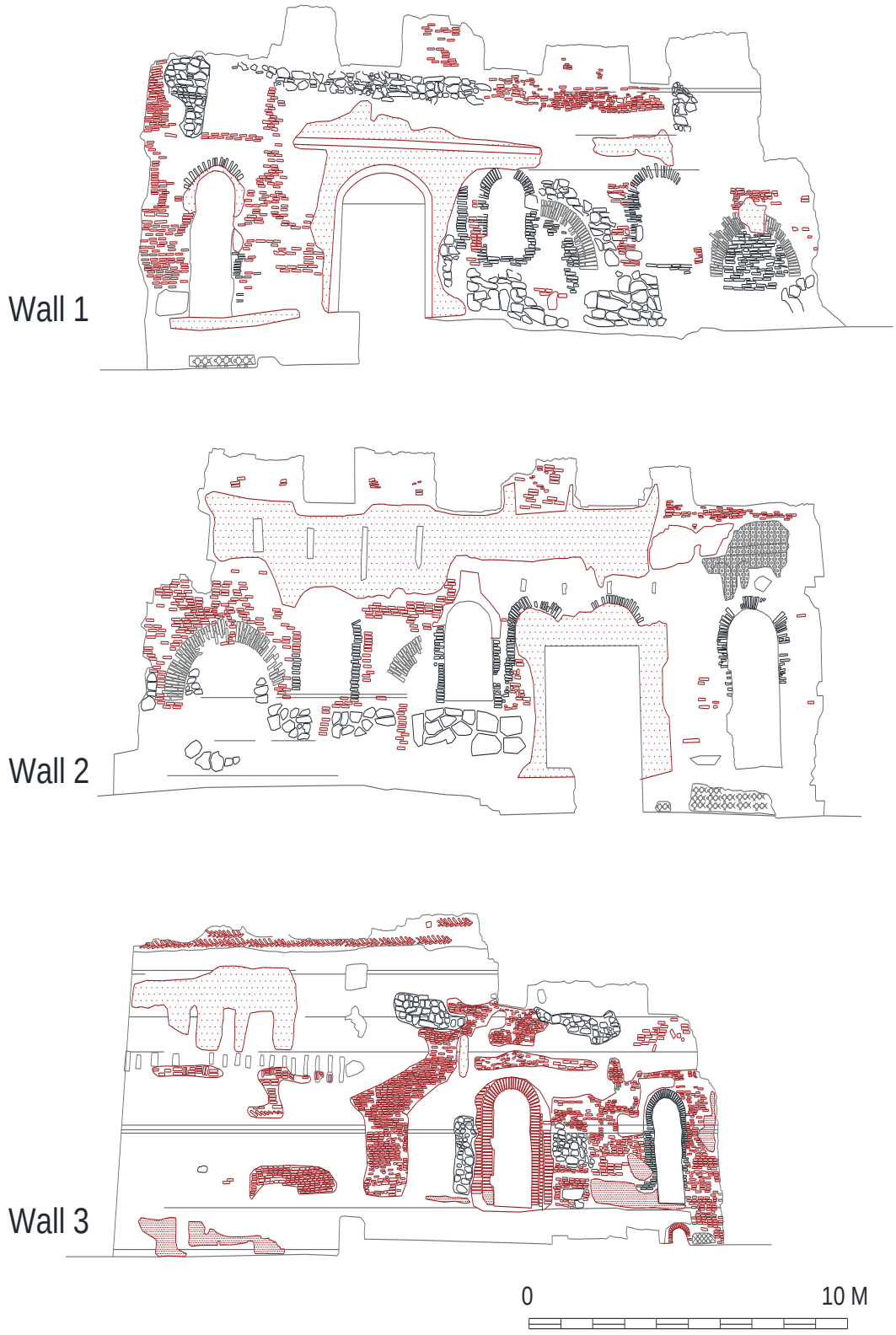


Fig. 3: Plan of the synchronic stratigraphic survey, of the El Mechouar Palace in 2009. Source: Authors


Wall 1
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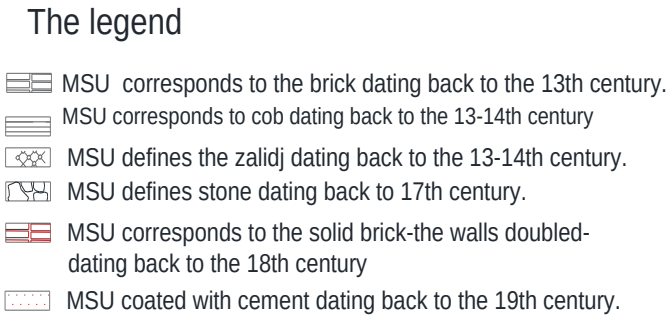


Fig. 4: An elevated view of synchronic stratigraphic records of El Mechouar palace in 2009
Source: authors

The opening system has changed its shape through three different eras. During the first era, the building consisted of semi-circular arch openings of solid brick, which were filled later with cob, and solid brick. The building during this era is probably part of an earlier construction, which was preceded by the construction of the palace in 1235 when the Zianide kingdom was founded. The openings are limited to 2.5 meters in height and 2.2 meters in width. During the second era, the opening system was characterized by a multiplication of openings that make up the exterior and interior facades. It was also characterized by a perfect symmetry provided by a rhythm of the opening that causes a radical change in dimensions (doors 3.2 meters high, the spandrel window wall is 1.8 meter that prevent the view). These transformations, probably Ottoman, constitute a passage from a palatial architecture to a domestic architecture and from ornamentation to austerity. The creation of the rooms in the patio evoked this aspect (Fig.5). However, they preserved the *zellige* that covered the ground. During the third era, the opening system was related to the transformations of 1843 under the French occupation. It was characterized by large interior doors, ensuring a better connection between the rooms. The walls were thickened with solid brick. Generally, the work carried out during this time was minimal.

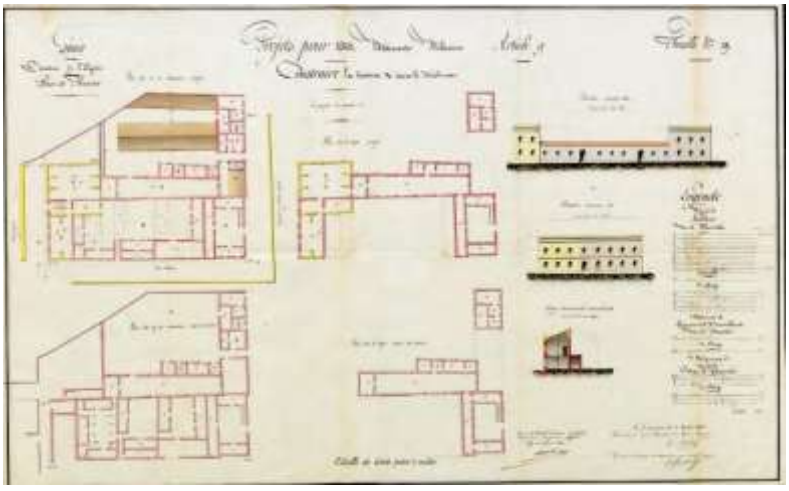


Fig.5: Plan and inventory of the palace in 1843.
Source: historical service of Defense (now SHD), Vincennes.

In 2010, a reconstruction of the palace damaged the authenticity of the archaeological site, ignoring the international charter recommendations of the International Council of Monuments and Sites (ICOMOS)-1990 adopted in Lausanne. This charter prohibited the reconstruction of archaeological remains. Algeria has been committed for a long time to conserve archaeological sites. The article 31 embodied in the law which was passed on June 15th, 1998 recommended the restoration of buildings included in the archaeological sites. However, it does not provide clear terms and clarifications that would protect cultural heritage.

All those interventions were prior to the authorization from the responsible Ministry departments. In short, Law 98-04 does not contain clear provisions on the issue of rebuilding the ruins.

Fig. 6: The condition of the palace before the operation in 2009.
Source: The National Office for the Management and Exploration of Protected Cultural Property (OGEBC), Tlemcen

Fig. 6: The palace after the operation in 2009.
Source: http://dta-tlemcen.dz/catalogue_detail.php?id=87&lg=ar&r=el_mechouar.

The intervention consisted of reconstructing the missing parts (Fig.6) using traditional construction techniques to reconstruct the roof, load-bearing walls, floors, stairs, porticoes, the fountains and the large basin. Likewise, the older walls were subjected to damage mending and consolidation, which integrally reinforced the supporting system and covered the stratigraphic units. A jacketing has been used to consolidate the old foundation into solid brickwork. A restitution of the ornaments comparable to those on the site took place. The distinctiveness was marked by increased thicknesses for the stucco decorations and slight nuances for the *zellige*. "It therefore, in short, possessed an architectural cloning form for therapeutic purposes,

intended to 'heal' the building" (Bastoen, 2008). A reconstruction approach adopts the Viollet-le-Duc`s philosophy: a complete state which may never have existed.

b) The Rampart and its Pathways

The rampart is a large fortress. Its original height varies between 7 and 12 meters. The enhancements undertaken in subsequent eras allow it to reach 14 meters while maintaining the proportions of the towers. Around two-meter-wide pathway circumscribes the top of the rampart.

"The other three sides of the rampart were dated back to the end of the Zianide reign between 1431 and 1461, after a century of the royal residence construction. However, the southern side included in the city rampart is dated back to the founding of Tagrart the Almoravids in the 4th century of the l'Hégire, 11th century (AD)" (Ibn-khaldūn, 1851, p. 343).

The rampart has seven towers (Fig.9), two doors that are opened in the middle of the West and South side as well as 11bartizan. Commonly, this enclosure is built with a compact cob, wrapped from the outside by a stone cladding, rubble and solid brick arranged in horizontal and herringbone levels. A twin tower of 21 meters in elevation, which marks the main entrance was elevated and reorganized during the French colonial era in 1845. It displays a Moorish architecture through pointed arches supported by columns. From the North side, two coupled towers emerge. They are marked by a vast terrace. The circular shape presents a particular defensive architecture that stands out from the other towers. They probably are dated back to the Ottoman period according to the report of the French engineers of February 5, 1836 drawn up by the Lieutenant-Colonel.

Some stratigraphic units appear today on the outer wall which represent the accumulations of different historical eras. However, making a synchronic record is difficult. This is because of the changes that accompanied the restoration operation in 2003. In addition to the consolidation work to safeguard the fortress, the works have witnessed the disassembly and jointing the stone and solid brick and the recovery of damaged parts at the level of the exterior facade of the rampart. This has radically eliminated the stratigraphic units. However, a previous intervention dated back to 1854 has been limited to the interior side of the rampart which was supported by arches as well as widening of the rampart pathway. The archives provide us with urban changes in 1880, embodied in the creation of roads and squares on the scale of the old Medina of Tlemcen. The southeastern wall was probably demolished in 1880.

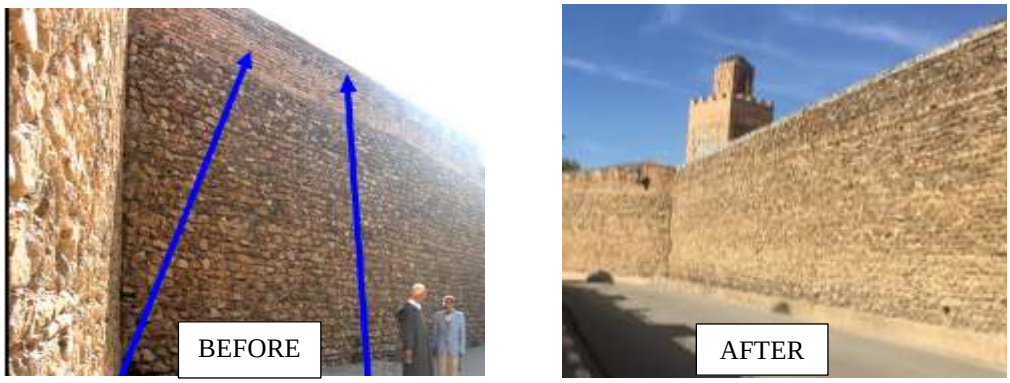


Fig. 8: The rampart before and after restoration, Source: The National Office for the Management and Exploration of Protected Cultural Property (OGEBC), Tlemcen

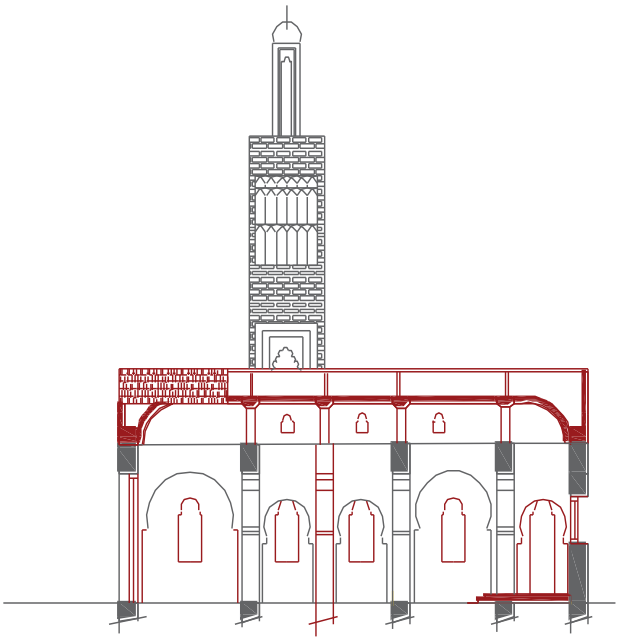
Fig. 9: Plan, a diachronic stratigraphic survey of the rampart of the El-Mechouar complex
Source: authors

c) The Mechouar Mosque

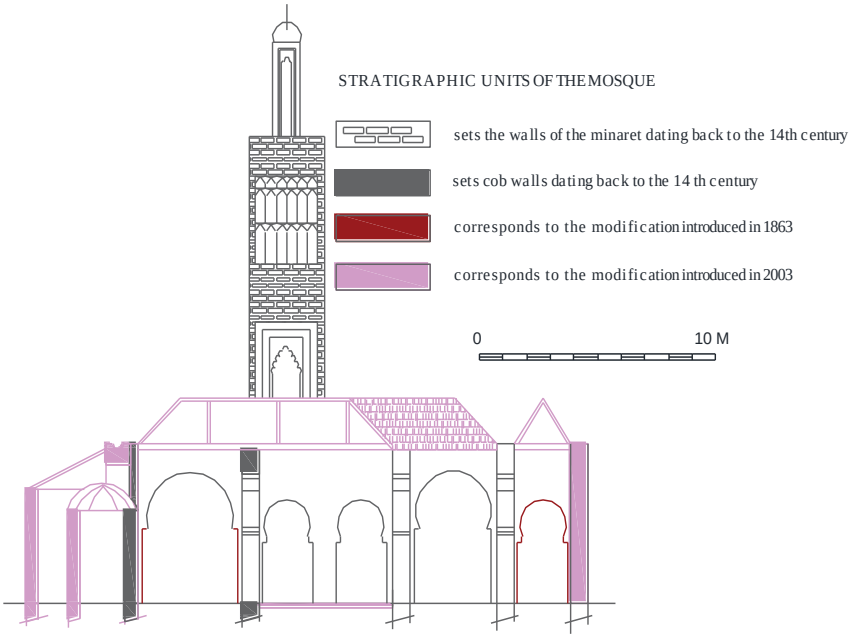
"The mosque was built in 1317/1318 by Abou Haj Hamou Moussa 1st. It is situated near the western rampart. It has witnessed changes during the Turkish era. It was transformed into a store annex to the military hospital, then into a Catholic chapel during the French colonization" (Georges, 1950, p. 82).

A diachronic stratigraphic sequence cannot always be assimilated to the total order. Therefore, our attention was paid to the transformations carried out from 1863 until 2003. Let us demonstrate what follows and what we could detect in the archive.

According to the plans, which preceded the modifications of 1863, the mosque had a minaret of 23.41 meters, which was visible from the outside of the rampart. It was unique and had polylobed arches and geometric ornaments in *Zellige*. A prayer room consisting of four naves parallel to the Qibla wall was located in the southeast. Masonry of load-bearing walls was composed of cob. Here too, the principle was the same. In the center, there was a small patio measuring 3.68 X 3.71 meters, surrounded by horseshoe arches, which constitute a source of air and lighting. Four doors forming the main entrances to the mosque. Two entrances along the minaret wall and the other two doors cross the southeastern wall.



TRANSFORMATION OF THE MOSQUE INTO A CHAPEL IN 1863



TRANSFORMATION OF THE MOSQUE INTO A MUSEUM IN 2003

Fig. 10: Longitudinal section, stratigraphic diachronic survey of the Mosque of the El-Mechouar complex, Source: authors

In this mosque, the roof is the most modified element with each intervention (Fig.10). In 1863, the new roof presented a typical Catholic Church model with its barrel vaults covered with tiles. The roof was set on low walls, which were made of solid bricks. Those walls, which were 3 meters high, were decorated by three windows with four lobes. Therefore, the whole building presented a late Romanesque style. A third door was opened into the southeast wall, forming a tertiary composition that carried sacred architectural significance in the Catholic religion. These changes would create a need for lighting that is resolved by opening windows along the four load-bearing walls.

In 2003, a restoration in the pre-colonial image required a multi-pitched roof reconstruction resembling the roof of the Zianid mosques, followed by a preaching hall reconstruction (*Maqsura*) which marks the *Qibla* wall. The walls were rebuilt owing to their advanced state of degradation.

The different layers (M.S.U) of additions and demolitions as discovered in this analysis:

A summary table has been drawn up (Table 1). It shows and brings together the obtained results that are previously interpreted. The results show the MSUs recorded for each building within each period. They also allow a comparative chronological reading before and after operations carried out between 2003 and 2010.

Table 1: The different M.S.U of additions and demolitions as discovered

		Before the restoration operation			**After the restoration operation (2003-2010)**		
PHASE	M.S.U.	Palace	Mosque	Rampart	palace	mosque	Rampart
13-14th centuries	The cob wall	+	+	+	Consolidation and covering with ornament	+	+
	the brick	+	-	+	+	-	+
	the*zellige*	+	+	-	+	+	-
	the stone	-	-	+	-	-	+
17th century	The stone	+	-	+	Demolish	-	+
	the buttress	-	-	+	-	-	+
	The opening system	+	-	-	Filled with cob	Filled with cob	-
	the zellige	+	-	-	+	-	-
18th century	The brick	+	+	+	Demolish	+	+
	The opening system	+	+	-	Filled with cob	Filled with cob	-
19th century	Render-coat	+	+	-	Demolish	Demolish	-
	The opening system	+	+	-	Filled with cob	Filled with cob	-
	The paving stone	+	+	-	Demolish	+	-
	The buttress	-	-	+	-	-	+

	The arch	-	+	-	-	Demolish	-
	The roof	-	+	-	-	Demolish	-
	The Pillar	-	+	-	-	Demolish	-
21st century	The cob wall	-	-	-	+	+	+
	the brikc	-	-	-	+	+	+
	The ornament	-	-	-	+	+	-
	The roof	-	-	-	+	+	-
	The column	-	-	-	+	-	-
	The carpentery	-	-	-	+	+	+
	The buttress	-	-	-	-	-	+

+: presence, -: absence

Source: Authors

Conclusion

Based on the historical approach and a stratigraphic survey which is similar to the sedimentary survey, we identify the main construction phases of the historical complex: Zianide (14th century), Ottoman (17th century), French 18th and (19th century), and after the Algerian independence (21st century). This investigation demonstrates that the Stratigraphic Survey is a useful diagnostic tool, which can be used in the restoration works that in turn intends to preserve the authenticity of the monuments. Therefore, a synchronic and diachronic stratigraphic investigation has to be applied.

The stratigraphic reading of the El Mechouar palace complex makes it possible to analytically document and date the constructive and destructive works that have caused illegibility of the original state. The masonry works are prevalent in the modification of the ramparts, the changes in the opening system as well as an integral reconstruction of the old palace. The stratigraphic units defining the historical value of the building have been mostly erased during the restoration operations in 2003 and 2010, which did not adopt a conservative intervention. Thus, it formed the complex interactions between the historic site and the stakeholders causing a loss of its authenticity. Indeed, the complex has almost completely lost its internal structure on several occasions. It was already mentioned that it underwent major demolitions in 1670, in 1847 and in 1990. Only the rampart and the minaret and some buildings of the French colonial era constituted the inheritance that has come down to us. Today, few stratigraphic signs attest to its historical journey.

The principle of reversibility was not respected during the restoration operations. This prevents the returning to the initial state without the risk of compromising the stability of the monuments. The archaeological excavations undertaken in 2008 have only presented 10% of the total surface. However, it is possible to expand the archaeological excavations on the entire citadel, which will allow the unveiling of its true historical value for tourist and educational purposes. Indeed, this study opens the way to other lines of investigations that deserve to be explored to refine certain aspects of this technique through approaches that integrate new technologies like the three-dimensional representation of the survey.

Today, it is necessary to popularize the use of these techniques in diagnostic studies taking into consideration the restoration and protection of the historical monuments in Algeria. It is also recommended to develop this technique and others, in a computer program that could allow the architects to conduct a precise diagnosis.

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