

quaderni di assorestauro



YEAR05NR01  
MARCH 2016

## WORKSHOP ICE-ASSORESTAURO LEBANON 2016

FOR ARCHITECTS,  
RESTORERS &  
ARCHEOLOGISTS

MARCH, 7<sup>TH</sup>-11<sup>TH</sup> 2016

## TRAINING WORKSHOP SEMINARS & COMMERCIAL MEETINGS IN LEBANON



ITALIAN TRADE AGENCY  
ICE - Agenzia per la promozione all'estero e  
l'internazionalizzazione delle imprese italiane

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Quaderni di Assorestauro



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## ITALIAN TRADE AGENCY

**ICE - Agenzia per la promozione all'estero e l'internazionalizzazione delle imprese italiane**

The ICE-Italian Trade Promotion Agency is the government organisation which promotes the internationalisation of the Italian companies, in line with the strategies of the Ministry for Economic Development. ICE provides information, support and advice to Italian and foreign companies.

In addition to its Rome headquarters, ICE operates worldwide from a large network of Trade Promotion Offices linked to Italian embassies and consulates and working closely with local authorities and businesses.

ICE provides a wide range of services overseas helping Italian and foreign businesses to connect with each other:

- identification of possible business partners
- bilateral trade meetings with Italian companies
- trade delegation visits to Italy
- official participation in local fairs and exhibitions
- forums and seminars with Italian experts



# asso**restauro**<sup>®</sup>

**associazione italiana per il restauro architettonico, artistico, urbano**  
italian association for architecture, art and urban restoration

*Project coordinator:*  
**Andrea Griletto**

Assorestauro is the first association established in Italy for materials, equipment and technology producers and service providers for the restoration and heritage conservation sector. Among the associations involved in this sector, which includes various institutional bodies that represent designers or restorers, ASSORESTAURO is the first to finally give voice to the industry and the sector of specialised services, promoting their interests in promotional, legal and cultural areas. ASSORESTAURO seeks to represent the sector, both nationally and internationally. In regard to the Italian market, an increased sensitivity towards our architectural heritage, together with the diffusion of new technologies, point to a growth in the sector in recent years, both from the cultural point of view (debates, magazines, conventions, exhibitions) and from that of technology (innovative materials, machines and equipment, software, plant design etc.). This provides the industry with a great opportunity for increasing and strengthening the occasions for dialogue, which are often lacking, with professionals, on the one hand, and with institutions (Government departments, Universities) on the other. As far as foreign markets are concerned, there is a clear perception of the need to capitalise on the great prestige that Italy enjoys abroad in matters of cultural heritage and on the remarkable investment in cultural technology that Italian companies have made in recent years, in order to translate specialist skills and know how into business opportunities abroad.

ASSORESTAURO therefore has the scope of coordinating, protecting and promoting the interests of its associated companies, and fostering their progress and development, endorsing their products and services and representing them in their relations with the institutions and organisations working in the field of research and training, regulations and promotion. It also acknowledges the support and patronage of the main restoration Italian Trade Show and Events, recognising, together with its associated companies, the value of a trade fair appointment that has become an international point of reference.

The company carries out the following specific activities:

- it promotes studies and research and collects news, items and statistical data useful for sector information, and carries out studies, monitoring and analysis of the situations and developments in the markets;
- it participates in the elaboration and publishing of international regulations for the qualification of associated companies, assisting them and protecting them in the certification of the quality and security systems of their products and services;
- it directly and indirectly organises training or updating courses, research and conferences for the development and dissemination of technologies and the use of their products;
- it promotes and holds conventions, synergies and agreements among associations throughout the world.





Alessandro Zanini  
*Assorestauro President*

The man can destroy the temple, never the God inside.

Cultural Heritage conservation is one of the most powerful weapons for peace and to join different communities.

Lebanon has had a difficult recent history but it teaches us that it's possible to live together. The will of Lebanon to preserve its Cultural Heritage is one of the most important signal of the strength of its community and its will to look to the future.

Italian Conservation excellence is here for supporting and enforcing this will and to leave here a clear and strong message of cooperation. Through the development of our relationship we shall build a very different "wall", erected on Culture, Innovation, mutual knowledge and respect. Not a wall but a bridge, useful for two Cultures that have a common History, made not only on contrast and fights.

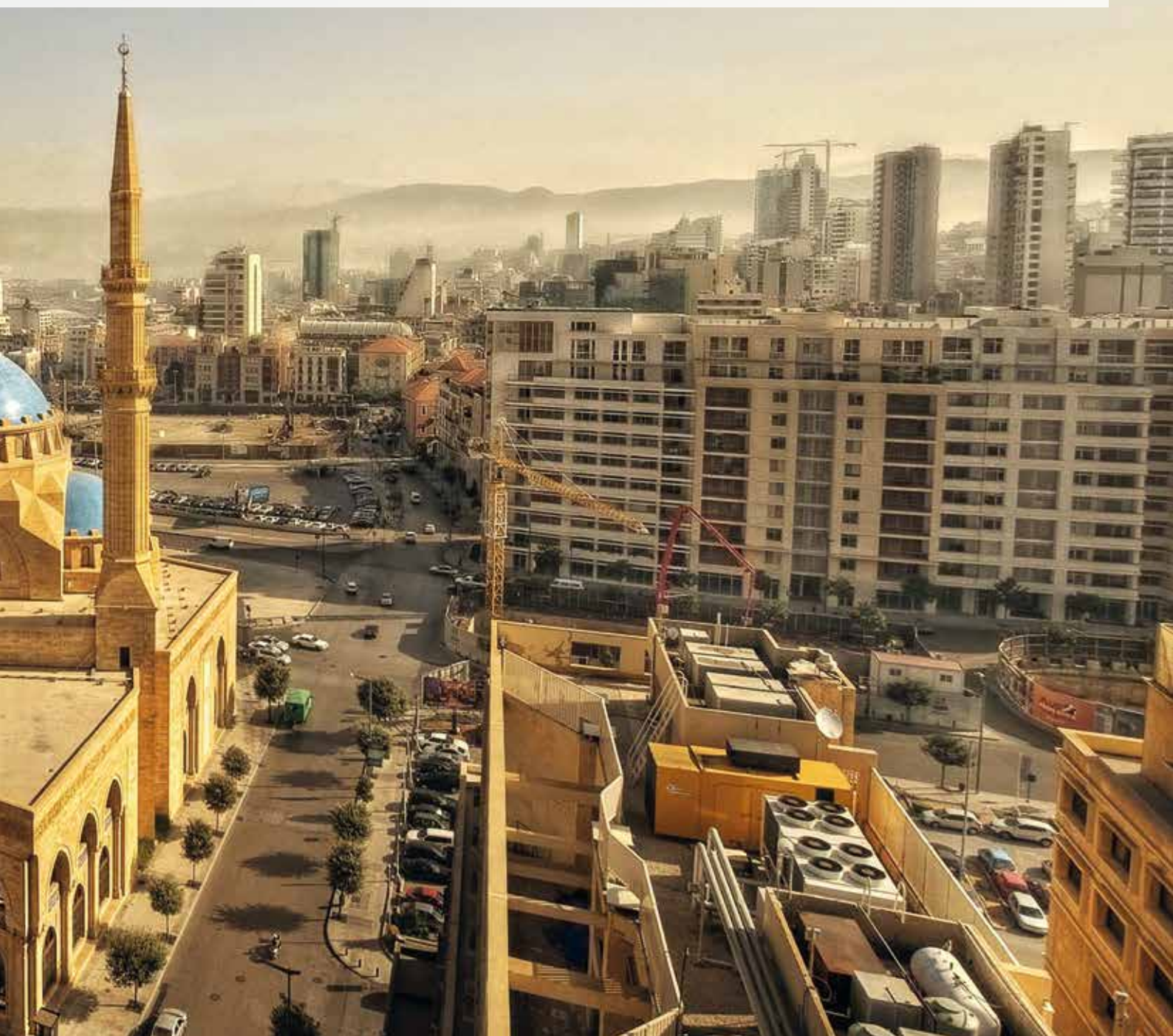




I'm very proud to come back in Beirut - fifteen years later my first visit as archaeologist – as President of Assorestauro. We have been working together for two years both to understand each other and to learn from each other. We represent the Italian excellence and the Italian experience, but, I always mention that: you can never bring the experience, you can only be a part of a sharing. Protection of Cultural Heritage and ,at the same time, showing our respect for the abroad Heritage is a particular task for us.

I'm sure that this workshop will represent a step forward for our relationship and a good opportunity for the companies of both our countries.

If there is someone who is trying to ruin the history and the several “heimat” of this wonderful Region, there is a larger and stronger community which is working together for giving a Future to the Past.





Davide Del Curto  
Assistant Professor  
in Building Conservation  
Politecnico di Milano,  
Dept. of Architecture  
and Urban Studies

## CONTEMPORARY ISSUES IN BUILDING CONSERVATION THE UNESCO WORLD HERITAGE SITE MANTUA - SABBIONETA

**The paper discusses some contemporary issues in building conservation, in Italy. The role of public and private players is presented within the regulatory framework. The UNESCO World Heritage Site Mantua - Sabbioneta is a case study**

### **The protection of built heritage in Italy: public and private players**

The protection of built heritage in Italy has been managed by public institutions since late XIX century. Since the Italian Ministry of Cultural Heritage and Tourism (MIBACT) was constituted for the protection activity in 1975, territorial agencies ("Soprintendenze") have been responsible for the protection of landscape and built heritage. Local authorities (Regions, municipalities) have a key-role as they own the largest historical properties and they are responsible for landscape and urban planning. The main restoration-conservation interventions of historic buildings and monuments in Italy have been performed thanks to the initiative and expertise of this public framework.

Not to mention the Catholic Church as the main non-state owner of heritage buildings, a number of private players have entered the field of built heritage conservation since years as proprietors or stakeholders. As an example, FAI (Fondo per l'Ambiente Italiano) is a pri-



**St. Andrew's Basilica  
in Mantua: mural painting  
of the apse**

(Photo D. Del Curto)

**St. Andrew's Basilica  
in Mantua: south-wing  
transept and detail of the  
wall painting decay**

(Photo D. Del Curto)

vate association inspired to the English National Trust which has got much visibility since the last twenty years as it has collected, restored and managed a number of historic properties obtained as a donation from wealthy families. A tax incentive policy has induced a number of private companies to undertake the way of building restoration as an investment or as a form of advertising, by sponsoring the restoration of monuments belonging to the State. This is the case of the Coliseum which has been restored since 2013 thanks to the sponsorship of a popular shoe factory.

More recently, the major banks have entered the field of conservation and heritage management as a dominant player. Banks directly operate as owners of relevant properties and art collections. Moreover, the bank foundations finance a number of activities related to cultural heritage: restorations, management, communication, training, museums. They operate as a charity foundation, taking advantage of a simplified financial bookkeeping. The legal framework concerns a no-profit activity while the intervention strategy stresses where state agencies leave off. This is the case of the built heritage sector, considering the lack of public resources to care of the huge heritage in Italy.



### The UNESCO world heritage site Mantua – Sabbioneta

The UNESCO world heritage site Mantua – Sabbioneta, in the Po valley, in the north of Italy, offer exceptional testimonies to the Renaissance culture, linked through the ruling Gonzaga family. Mantua is a ancient town which was renovated in the 15th and 16th centuries as a prominent capital of the Renaissance thanks to the participation of renowned architects like Leon Battista Alberti, and painters like Andrea Mantegna. The nominated property covers 175 ha. with 41,000 inhabitants. Sabbioneta represents the construction of an entirely new town according to the modern vision of the Renaissance. The well preserved urban structure, defensive walls and city monuments make Sabbioneta one of the best examples of ideal cities ever built in and outside Europe. The nominated property covers 60 ha. with 1,000 inhabitants. Built heritage has been crucial to the UNESCO statement of universal value in 2008 and meets the required conditions of integrity and authenticity, since it has been preserved over time. The legal protective structure and management system has been considered adequate, as both properties exhibit a good state of conservation.

After the UNESCO statement, new restorations have been promoted by the main banking foundation operating in Lombardy within the cultural heritage field. The State does not finance integrally the restoration of a public building and in order to undertake such a costly operation, local administrations need both a technical, both an economical project, that is how to co-finance. Some biggest restorations have been completed, e.g. the Co-Cathedral of St. Andrews in Mantua whose interiors have been restored since 2007 to 2014 with an investment of 13 MEuro. Beside main monuments, the banking foundation operates with a

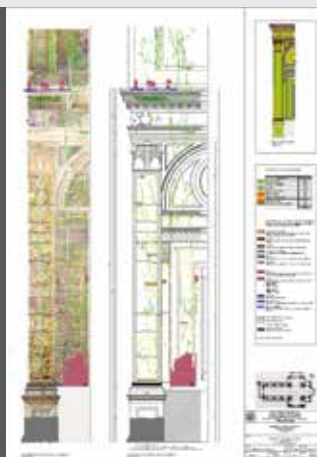
The city walls of Sabbioneta: present state and situation in 1985. The walls were built within 3 campaigns (1556-67, 1578-79, 1584-1600) in the shape of an irregular hexagon. They were abandoned for centuries and restored since 1994  
(Photo D. Del Curto/Private collection)



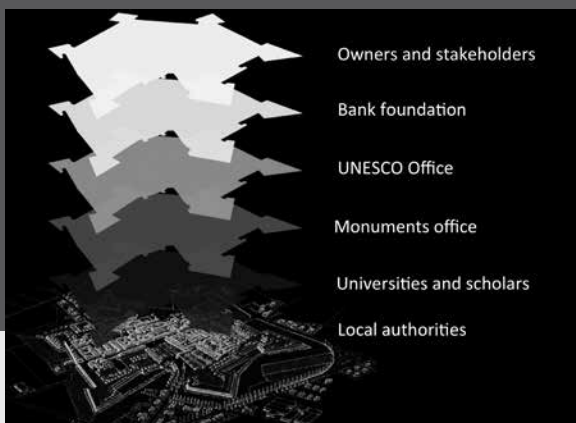




**St. Andrew's Basilica in Mantua: decay mapping in the pilot-yard**  
(Photo and drawing D. Del Curto)



**St. Andrew's Basilica in Mantua: dome, interiors**  
(Photo D. Del Curto)



**Collaboration is crucial in building conservation**  
(Elaboration by D. Del Curto on a drawing by L. Confortini)



territorial strategy of “minor” interventions. A program named “cultural district” promoted a partnership of local administrations and private bodies, with a focus on the preventive conservation of built heritage. Little municipalities had the opportunity to undertake projects otherwise unaffordable. E.g. remarkable resources have been destined to restore the walls of Sabbioneta, on the basis of a project for their valorization. The conservation of the city walls has thus been an opportunity for the local economy, in particular for the building sector operating in the field of conservation.

However, the most recent interventions have been oriented towards traditional restoration, while a strategy of preventive conservation is still lacking. The UNESCO management plan has been hard to implement and coordinate with the regulatory and institutional framework. A monitoring of the results is still missing. (Badia 2011)

The little town of Sabbioneta is nowadays an interesting laboratory to test how efficient is the multi-layer structure operating in the building conservation field: public agencies, universities and research centers, UNESCO office, banking foundation, private companies and professionals, owners and stakeholders. (Balksten, Del Curto, Légner, 2014)

Eight years after the UNESCO statement, “collaboration” is still the key word.

Pasquale Crisci  
Gianfranco Laezza  
Gennaro Di Lauro



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## RESTORATION AND SEISMIC RETROFIT OF “VILLA GUARRACINO”. TORRE ANNUNZIATA, NAPLES

The building called “Villa Guarracino” is located in Torre Annunziata, overlooking the bay of Sorrento, in the south of Italy.

The building is part of a large complex, known in the past as “Filangieri’s Complex”. The construction, also called “The Castle”, was built by the French government as a military fortress in 1500s. The destination of the building changed over time, in the last the Filangieri Family used it as residence until 1980, when it was abandoned after the damages caused by the earthquake.

The current owner intends to convert it into a luxury resort with the intention of preserving the traces of its long history, leaving intact the details that the different uses have determined. The architectural design approach takes into account the fundamental rules for the restoration of cultural heritage assets. The scope is to guarantee a current and functional use of the building respecting the classified uses until its state of abandon.

The seismic retrofit design can be classified as seismic improvement intervention in compliance with recommendations and guidelines for historical-artistic buildings, as specified in the Italian code “NTC 2008” and guidelines of Ministry of Cultural Heritage “DPCM 2011”.

### 1. INTRODUCTION

The building called “Villa Guarracino” is located in Torre Annunziata, overlooking the bay of Sorrento, in the south of Italy.

The building is part of a large complex, known in the past as “Filangieri’s Complex”, taking this name from the Neapolitan noble family who possessed the entire complex in the past century. The construction, also called “The Castle”, was built by the French government as a military fortress in 1500s. The destination of the building changed over time, in the







On-site test with Double Flat Jacks



On-site test: Endoscopy

last the Filangieri Family used it as residence until 1980, when it was abandoned after the damages caused by the earthquake.

The current owner intends to convert it into a luxury resort with the intention of preserving the traces of its long history, leaving intact the details that the different uses have determined.

## 2. HISTORICAL OVERVIEW

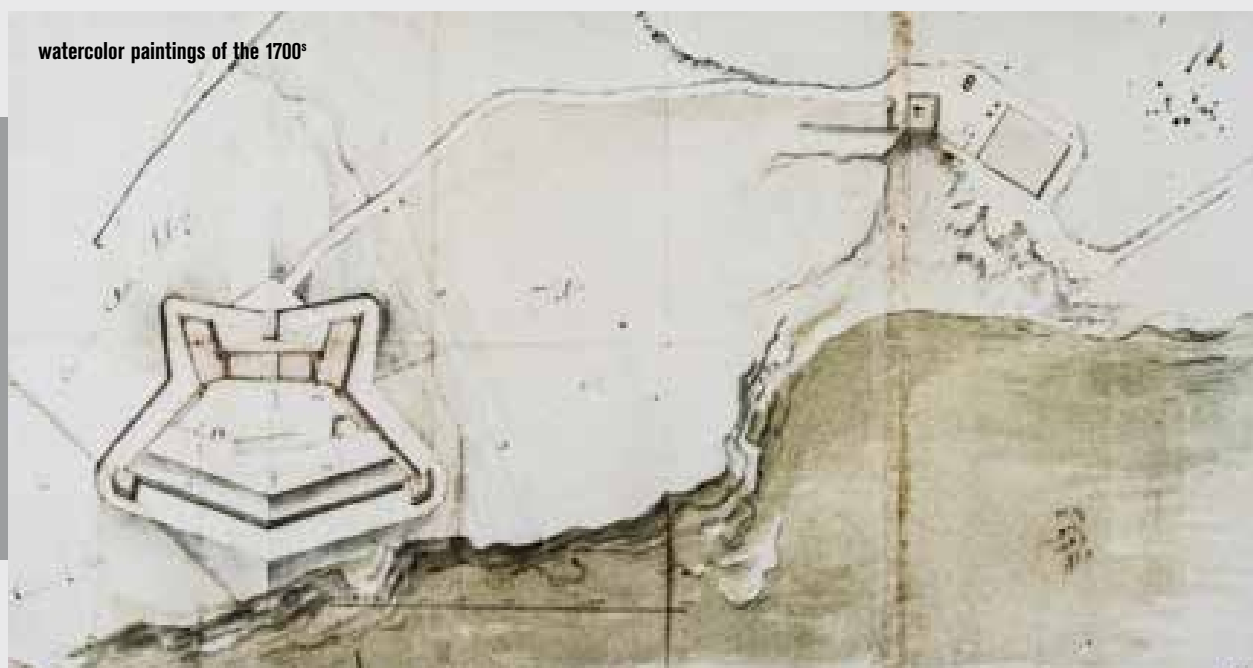
### 2.1. HISTORICAL-CRITICAL ANALYSIS

The building was originally a Bourbon fort in the 16th century for the monitoring and protection of the coast against enemy incursions coming from the sea, it was known as Ancino fortress. The military complex in Cape Ancino gives us the image of a trapezoidal barracks protected by a wide moat and with two sides along the coast, whose sea defence was ensured by two turrets and low-rise bastions with a singular semicircular plan-shape. The profile of the sheltered fortress, just emerging from the promontory, hid an articulated structure with underground rooms used as storage and a large parade ground with the lodging of the commander and the garrison.

The role of the building changed decisively with the birth of the Kingdom of Italy. The fort passed in the property of the State and put up for sale. From that moment and until the first half of the 20th century the fort became the scene of social events for the Filangieri Family.

The new owners did not make efforts to preserve the original structural and functional integrity of the building, but they made several changes aimed to adapt the building to the new destination, except changing the original layout.

In this way, the construction lost one of the elements that constituted the most distinctive aspect of its original function, becoming a typical summer residence for the Family and its guests.



watercolor paintings of the 1700s

## 2.2. DESCRIPTION OF THE BUILDING

The building shows its character of a military fortress with a U-shaped plan with the long side oriented in an east-west direction, with a direct sea view. The two short blocks of the U-shape are tilted in the opposite direction, one in the north-east and the other north-west. The property consists of the following levels: ground floor with an area of 530 sqm; first level of approximately 320 sqm, which rests on the central long side, while the two lateral blocks are single-story; attic of approximately 125 sqm with a pitched roof.

In front of the building it is placed a pentagonal-shaped courtyard that containing into the two south-east and south-west corners, two emerging towers.

From the entrance on the north side, the structure offers to the visitors the main façade, characterized by a pattern of horizontal plaster bands that cover the entire ground floor, with a central balcony on the first floor surrounded by balustrades. The first floor is characterized by arched windows equipped with patterned decorative friezes. On the top, the façade is crowned with battlements.

Through the aforementioned entrance, which can be accessed by a suggestive 'bridge', the guest arrives in the pentagonal-shaped courtyard.

The interior façade has not particular architectural elements, as it has preserved the austere original military features.

The other façades are similar to those internal and present, as prevalent feature, the only cited lookout towers.

## 3. RESTORATION AND CONSERVATION DESIGN

The architectural design approach took into account the fundamental rules for the restoration of cultural heritage assets, due to the historical and cultural interest of the building.



watercolor paintings of the 1700s



The scope has been to guarantee a current and functional use of the building respecting the classified uses until its state of abandon: social uses for the ground floor and residential uses for the upper floors. During the stages for the consolidation of foundations of the two side wings of the building, it was found that the original floor was deeper than the external walking level of approximately 3 m and furthermore the filling material was loose type. This revealed the existence of underground rooms used in the past, then filled for some reasons. A similar situation was found in the two lookout towers on the south side. On this basis, the project provided for the recovery of the relieved underground spaces and their extension outside the perimeter of the building through two new underground volumes, completely hidden from view and separated from the main building by mean of construction joints. In the following it is described in the details the structural project which involved the original main block.

## 4. SEISMIC RETROFIT DESIGN

### 4.1 DESCRIPTION OF THE STRUCTURAL SYSTEM

The structural system consists of bearing walls made up with tuff masonries mixed, in certain zones, with soft lava stones. The thickness of the bearing walls is variable both in plan and in elevation of the building.

On the ground floor masonry vaults are visible resting on arched walls. The masonry vaulted structure is the solution used for the intermediate floors and presents different typologies: barrel vaults and rib vaults, widely varying in size. On the ground floor, the system is not well-structured, vaults are interconnected by lunettes or spherical joints; on the upper floors the vaulted surfaces appear simple and more regular.



The roof has a load-bearing structure with wood pillars and beams.

The foundation structures are made with a deepening of the vertical walls of more than 3 m from ground level. The surveys showed the walls go far beyond the first layer of topsoil, resting on the volcanic and lithic soil that is placed in a range between 2 and 5 m depth from the ground level.

#### 4.2 THE KNOWLEDGE PHASE

The project concerned the works to be executed on an existing construction, for this reason it was paid particular attention to the “knowledge” phase of the existing building.

Generally, there are three factors determining the “Knowledge Level” (KL), they are:

- \_ **Geometry:** the geometrical properties of the structural elements and such non-structural elements that may affect structural response;
- \_ **Details:** these include the amount and detailing of connections between structural members, e.g.: connection of floor diaphragm to lateral resisting structure, the bond and mortar jointing of masonry and the nature of any reinforcing elements, etc.
- \_ **Materials:** the mechanical properties of the constituent materials.

In almost all technical specifics (e.g. “Eurocode 8” or Italian code “NTC 2008”), the achieved KL determines the allowable method of analysis and the values to be adopted for the Confidence Factor (CF), the latter the factor that corrects the mechanical properties to be used in the analytical calculations.

In this assignment the achieved KL was equal to KL2 - Normal Knowledge.

The survey on the geometry and details included:

- \_ thickness and typology of bearing walls;
- \_ geometry, composition and layering of foundation, floor and roof elements;
- \_ structural openings details in term of characterization of the structural efficiency of sub-window (sills) or up- doors/windows (spandrels);
- \_ quality of connection between horizontal and vertical elements;
- \_ quality of connection among intersecting bearing walls;
- \_ crack pattern and state of conservation state;
- \_ structural details of other connections between structural elements;
- \_ presence of structural or non structural elements of high vulnerability.





Regarding the knowledge of materials, the experimental tests included:

- \_ 3 on-site tests with single and double flat jacks;
- \_ 3 laboratory tests on the mortar;
- \_ 2 laboratory tests on extracted cores by r.c. elements with execution of compression and carbonation tests;
- \_ 2 laboratory tests on bars extracted by r.c. elements with execution of the tensile tests;
- \_ 5 on-site tests by means of Resistograph equipment, for the determination of the quality of wooden elements;
- \_ several endoscopic surveys through the masonries and the vaulted thickness.

#### **4.3 STRUCTURAL MODELLING AND SAFETY CHECKS**

On the basis of all the previous information, the structural model has been defined in order to develop the numerical analysis and the safety checks.

The structural model assessed two different issues: the so called “first-mode” damage mechanisms, which involve out-of-plane failure mechanisms, and the “second-mode” damage mechanisms which are associated to in-plane response of walls.

The assessment of the first mechanism passed through the “kinematic” analysis of collapse mechanisms, generally analysis of simplified partial sub-models (e.g. co-planar two-dimensional models).

The assessment of the “second-mode” damage mechanism passed through the non-linear static analysis for a global three-dimensional model, the so called Pushover Analysis, that is claimed as the more appropriate method for the structural assessment of the masonry buildings.

#### **4.4 DESCRIPTION OF INTERVENTIONS**

The interventions have been chosen on the results obtained from the numerical analysis of ante-operam status, fully in compliance with recommendations and guidelines for historical-artistic buildings, as specified in the Italian code NTC 2008 and guidelines of Ministry of Cultural Heritage DPCM 2011, thus respecting the principles of minimal invasiveness, reversibility and sustainability.

The project can be classified as seismic improvement intervention since it is aimed at increasing the resilience of the structure to seismic actions without altering the characteristics of its historical evidences.

The intervention, thus taking into account the expectations about the earthquake safety, is made compatible with the architectural, historical and environmental values of the building.

The general aim of the seismic retrofit design is to provide the building with a continuous load path, resistant to the gravity loads as well as the seismic actions, so to avoid the local structural failures.

Apart of local interventions, the global interventions are finalised to achieve the structural integrity, giving to the structure the ability of maintaining the interconnection between the structural chain made up of several links (e.g.: roof elements, floor elements, bearing walls and footings), in other terms the so called box-like behaviour.







Hereinafter the main interventions provided by the structural design are described.

**In-plane stiffening by reinforced concrete slab** ■ The intervention consists in the realization at the extrados of the vaults of a reinforced concrete slab, made up of lightweight aggregate concrete. The concrete slab is made cooperating with the lateral bearing walls by means of galvanized steel anchors injected with epoxy.

**Steel tie rods** ■ The metallic ties are designed like traditional connections except for the use of corrosion-resistant material, through a galvanization process. They are applied in the north-south direction on the first floor in order to improve the connections between the vertical structures and vaults, preventing the overturning failure mechanisms of the façade.

**Ring beam with Carbon Fiber Reinforced Polymer (CFRP)** ■ The CFRP ring beam is placed on the outer side of the building on the second floor level. The intervention is aimed to: i) improve the connection between the horizontal elements and walls and ii) improve the connection between orthogonal walls so as to enhance the three-dimensional behavior of the structure (box-like behavior.)

**Stitching interventions with reinforced perforations** ■ The intervention is aimed to reconstitute the structural continuity between cross juxtaposed walls built in different eras, by means of reinforced perforations, made of steel rods embedded in cement grouts. The steel rods are designed to be galvanized to prevent the corrosion.

**Repointing** ■ The intervention has only involved the run-down walls, mainly on the ground floor. The intervention consists of the partial replacement of the mortar joints with better quality mortar, in order to improve the masonry mechanical characteristics. Thanks to the tests executed on the existing mortar it has been designed the mortar mixture very close to the existing one.

**Supporting of masonry walls with steel elements** ■ The geometric survey pointed out the presence of some irregularities in the elevation of bearing walls. In particular way, some walls of the upper floors interrupt their continuity at ground floor. The weight of these walls is supported by the vaults, that present a crack pattern at their intrados. This irregularity has been corrected by coupling the masonry walls with steel beams, placed at the wall basis. In a such a way the wall is supported by the steel beams resting on the orthogonal walls and the vaults are relieved of the heavy weight.

**Local interventions** ■ Among the designed interventions there are some other so called local type, e.g.: closing of the niches, new steel lintels, connection of the roof wooden joists to the walls, reinforcement of wall openings.

**Daniele Fanciullacci**  
C.E.O.

**Patrizia Barucco**  
Director of Culture and  
Cultural Heritage Sector

**Laura Nicolini**  
*Conservation Architect*

**A.R.S. PROGETTI SPA**  
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# BAALBEK AND TYRE ARCHAEOLOGICAL PROJECT

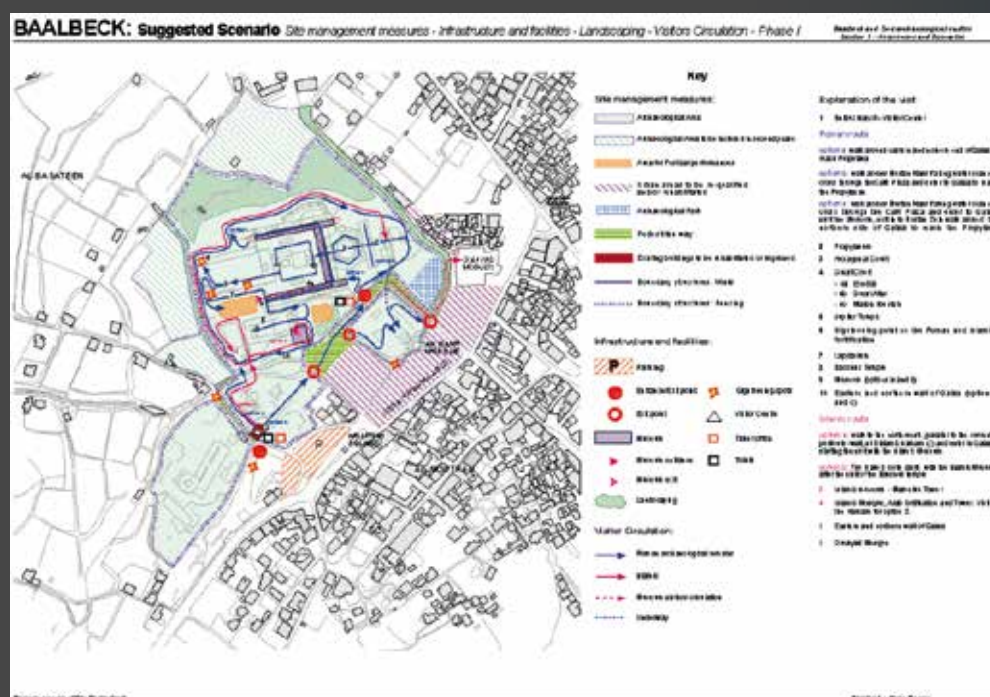
The advice of ARS Progetti for Baalbek and Tyre Archaeological Project began about 16 years ago when in 2001/2002 ARS Progetti carried out the studies to identify the project components of the Baalbek and Tyre Archeological Project, BTAP, within the framework of the Cultural Heritage Urban Development project to be co-financed by the World Bank. Afterwards, since 2008 and still ongoing, ARS Progetti carry out the Design and Works Supervision for Phase 1 work package, which includes a number of site facilities and infrastructures and the conservation interventions on key monuments.

The general objectives of the BTAP project are: a) Enhancement of the cultural and educational potential, b) Enhancement of the visiting experience, making it unique and memorable, c) Improved income and employment generation for the local population and for the country, d) Preservation of the significance of the cultural resource and sustainable use of the areas, based on restoration, conservation, and prevention from threats.

The measures identified by the study and incorporated in the BTAP framework are: 1) Administrative measures: a) capacity building and institutional strengthening within the DGA; b) management planning; and c) basic documentation; 2) Essential conservation measures: urgent and basic measures that need to be taken, to stop most serious deterioration processes; 3) Common development measures: a set of infrastructure, visitor management and presentation measures, identified after the assessment of present conditions, which are effective and easy to be achieved.

In 2001/2002 the study developed the Analysis of the state of the sites, including the conservation and presentation conditions and the potentialities (an analysis of values and sig-

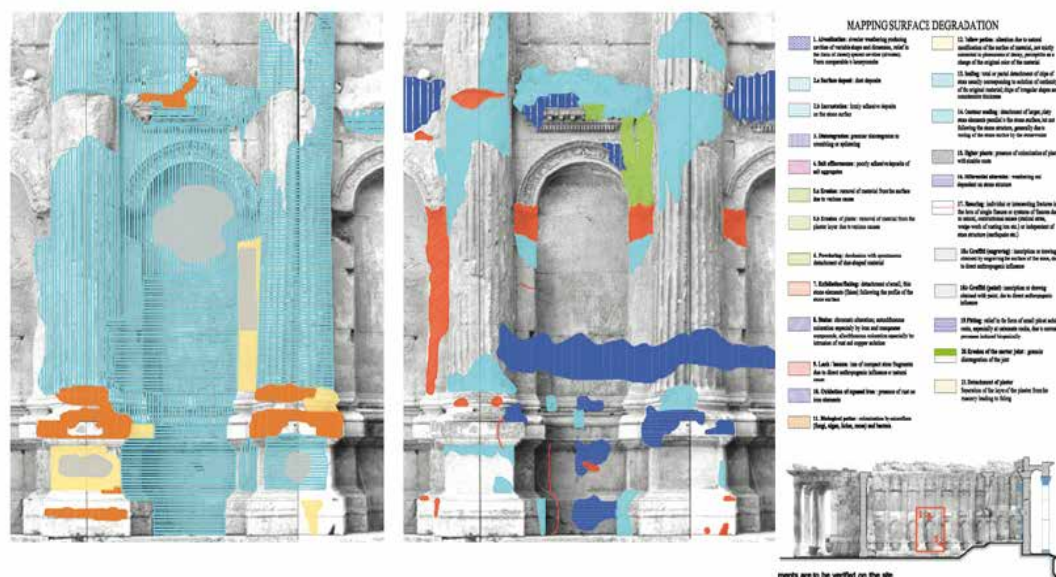
The final output of the study carried out in 2001/2002 was consisted of the detailed reports regarding the “Assessment and scenarios” including the documentation of conservation problems, the “Project measures consisted of the technical reports and two sets of drawings detailing the measures for Baalbek and Tyre, and the “Implementation plan” articulated in three action areas: 1) Presentation and archaeological measures; 2) Landscaping and infrastructure; 3) Conservation for structural engineering measures and surfaces conservation.







## 2 - BACCHUS TEMPLE Mapping of surface degradation

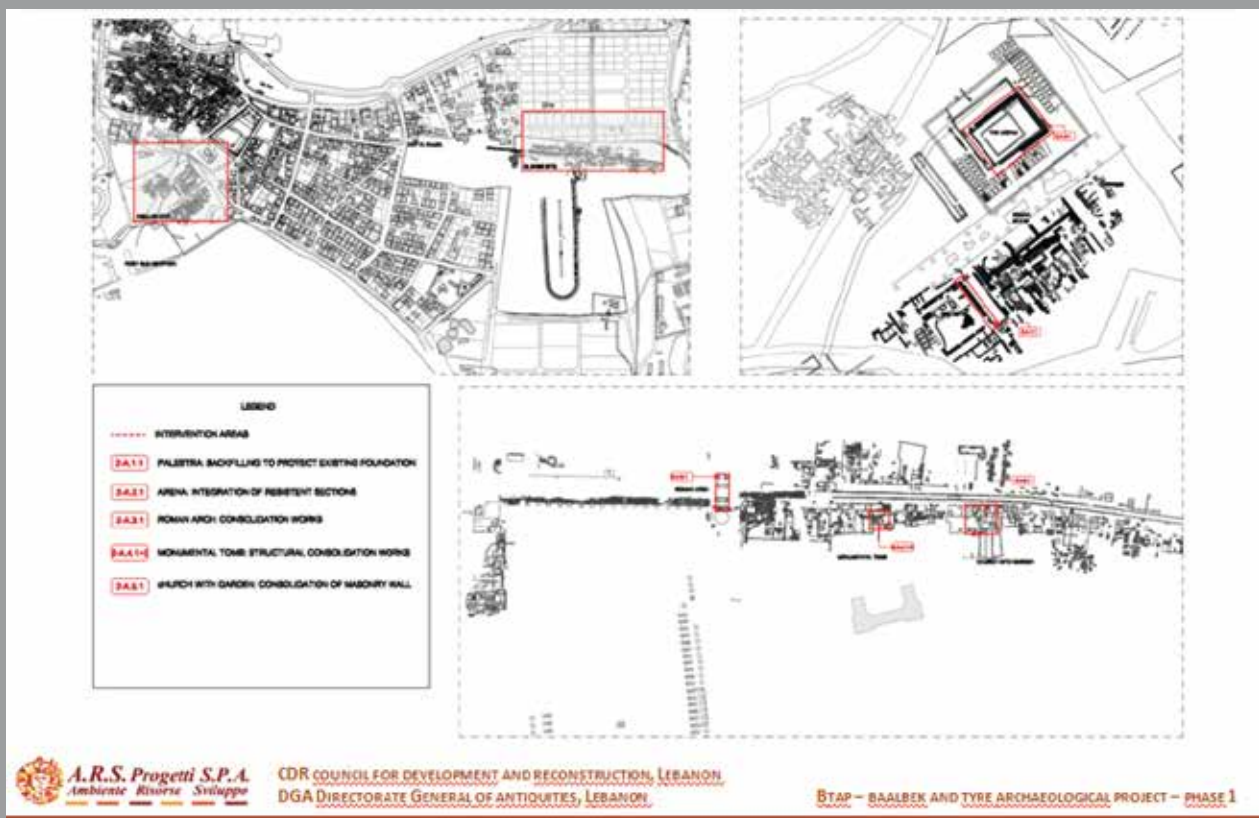


nificance of the various monuments and sites, an assessment of their physical conditions and threats, an assessment of presentation and management facilities, analyses the tourism development options, an assessment of the management context), the development of alternative scenarios for the conservation and development of the sites (Aesthetic/perceptive scenario versus Discovery scenario, Preferred/proposed scenario and essential and scenario interventions), the preparation of preliminary design and estimate of the priority interventions, Implementation strategy and plans (for 5 and 10 years plan).

Starting from 2008, the interventions identified in 2001/2002, were organized and tendered for further design and works in two different packages: BTAP1 and BTAP2.

In 2008, ARS Progetti carried out the design and tender documents of BTAP1. The first design and tender documents was for the Infrastructures (for Baalbek site: new entrance and ticket office, toilets, visitor center in Beit Nassif, storage and laboratories, police station, fences; for Tyre: City site ticket office & guards room, City site DGA visitor center, El Bass site main entrance ticket office & parking area, El Bass site museum complex, museum, cafeteria, toilets & police, El Bass site Hamra entrance ticket office). The second design and tender documents was for both the Surface Conservation (for Baalbek site: Exedra; Bacchus Temple; Venus Temple; for Tyre sites: Roman Bath, Grande Hallée, Colombarium, Monumental Tomb, Church with Garden, Sarcophagi, Roman Arch, Church near the Arch) and the Structural Strengthening (for Baalbek site: Propylaea; Hexagonal Court, Exedra, Arab Tower, Perimeter Wall, Bacchus Temple protection; for Tyre sites: Palestra Colonnade, Arena, Roman Arch, Monumental Tomb, Church with Garden).

GENERAL PLAN with location of structural consolidation measures





In 2009 the tender process was unsuccessful and the works were divided in two works packages and tendered again: Package 1- Infrastructure (implemented: 2010 - 2013) and Package 2 - Conservation Package (2014 - on going).

For the conservation works it was faced the problem of lack of skills and the need for appropriate training for local workers . In fact, the Contractor for the Conservation Works (JESCO Contracting Trading & Enterprising) firstly employed a German restorer and later searched for a growing number of restorers in Italy, which are training on the job local skilled laborers. The works being carried out include the use of specific products for conservation and structural consolidation often completely unknown to the contractor and , to a certain extent, also to local professionals. Despite the Contractor searched widely for products available on the local market, these rarely have passed a positive evaluation by the WS. Then the Contractor had to address the research to the Italian market where firms producing products for restoration can boast a long experience and their products were tested in a long time.

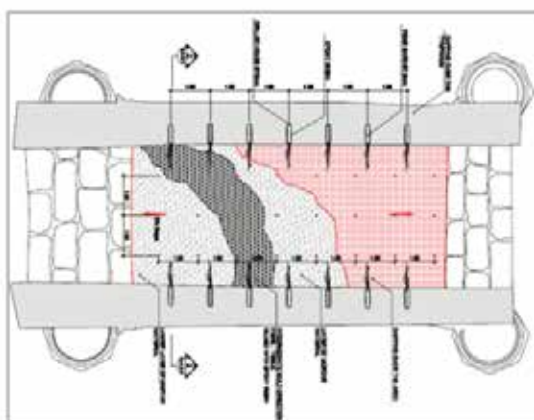
Another important aspect is the specific equipment needed to perform fine detail works such as those for cleaning surfaces using different types of sandblasting and other more sophisticated equipments such as laser.

Finally, a particularly sensitive issue is the safety of operators in site, for which there is still little attention. In the field of conservation this is of particular importance for the continue exposure of workers to highly toxic or polluting agents such as chemical or abrasive substances.

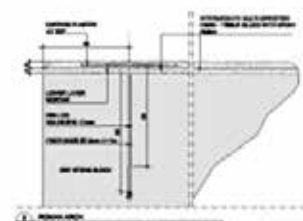
### 3 - ROMAN ARCH - Structural consolidation works

#### Reinforcing capping masonry with:

- fiber-reinforced mortar
- intermediate quadriaxial aramidic fiber fabric glued with epoxy resin.



Alghero 1982



Alghero 1982



Alghero 1982



IL CASTELLO NEL  
TESSUTO URBANO



Rosa Carafa  
Vincenzo Guadagno  
Enrico Carafa

## RESTORATION AND RENOVATION OF UGENTO'S CASTLE (LECCE)

**CGA**  
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### INTRODUCTION

The Ugento's Castle is situated in the Northern area of the city and it occupies an area of quadrangular shape. The building, situated in the highest point of the urban fabric, it closed the circuit wall in the weakest point, contributing to the defense of the center with two circular towers north transformed, to receive the pieces of artillery, from Pandone, using the shoes of those Angevin after the destruction of the center and the castle by the Turks in 1537. The building is a structure of local tuff, made indifferent times, once at the edge north of the town, set on a large area quadrangular. Its conversion into a noble residence, must register to d'Amore who buy the estate in 1643, when the building had lost its defensive function. Considered one of the most important manor of Otranto's land, where the Angevin kings always showed a predilection, the building retain sits character and organic and unit, typical of the big factories built in the pre-modernage.

### METODOLOGY

The Restoration's Project of Ugento's Castle, his conversion, besides enhancing the manufactured object of intervention, allows to visit the existing with the language of contemporary architecture, creating a stratification with the architecture of the past which leads to the interventions of the future. Inspired by the idea of the "union" between historical and contemporary, it proposes a clever play balance in the use of materials and design choices.

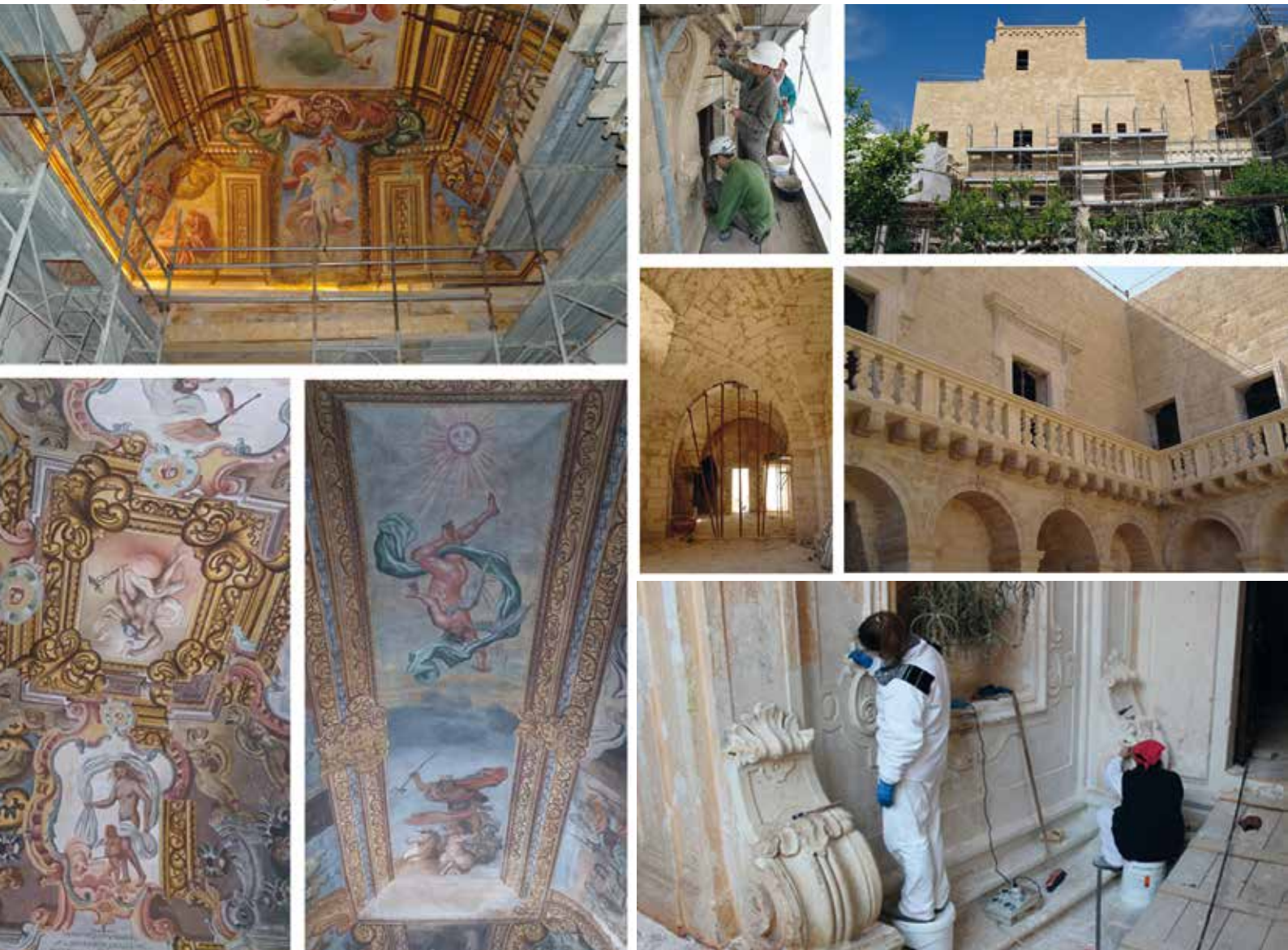


The architectural language takes visitors on an suggestive narrative sequence through the alternation of starry vaults left exposed in their natural stone typical of the area and long vaulted spaces into fights made suggestive by the play of light that makes it unique and strongly characterized the intervention. In the project was valued compatibility on an architectural scale, ensuring that the desired function is not cause a distortion of the physical substance and form of the building to be restored, neither the supporting structures and that the selected function was culturally compatible with an asset subject to intervention. In the definition of the plant functional, account was taken also the need to start processes of regeneration of the surround in urban context. So the renovation provided for a mix of functions identified in a museum built in the frescoed rooms on the first floor, in an international cooking school and a hotel made in the areas on the ground floor and the first floor of the wing named "alcove". From a strictly technical point of view, interventions were identified, described and represented in reference to the various types of existing artefacts (walls, wood, steel and reinforced concrete, etc.), in reference to the various materials (stone, wood, metal, etc.) and with reference to the particular state of conservation (disruptions, degradations and alterations, etc.). An important role in the choice of the types of technical-operating privilege, has been attributed to the policy of minimum intervention, to compatibility demonstrated of products to be used. The strategic objective chosen was to not alter the work and its consistency constructive, opting preferably no destructive techniques and no-invasive, in realistic consideration of the relationship between means and ends, and the demands of security and conservation of the built environment. On the methodological side and operational restoration project was divided into three categories or distinct phases: those designed to ensure the structural safety, where addressed to inhibit and reduce the degenerative processes of materials (preservation of materials) and those directed a removal or addition of parts and components, where these actions are deemed necessary or functional fruition (reintegration).

In fact all design decisions took account of will of limit intervention to the simple and essential rehabilitation and functional reorganization of the interior, where possible. In the







presence of the collapsed parts, destroyed or significantly altered it as set itself the necessity, of ensuring efficiency and reliability to the arte facts involved. In that case, the intervention resulted in adapting technology and correlative realization of works (partition walls, floors, suspended ceilings, and more) that introduce new elements in the team inside and outside work. In this case, as with another type of intervention industrial universe, the principle of the different product durability modern compared to those of the pre-modern past, and therefore the need to carry out any of the technological equipment without bringing destruction of the ancient material.

### THE INTERVENTIONS

In the detail, the technical work needed for the purpose consisted of a detail deprogram related to multiple and complex activities, comprising:

- Consolidation of arches and vaults, with the sealing of the lesions and affixing on extradoses hoods fibrous materials resistant suitably anchored to the perimeter of the structures arched and made integral with resins.



- \_ The creation of partition panels as partition walls;
- \_ The realization of elevators;
- \_ The installation of new flooring and coatings;
- \_ The laying of wooded window frames;
- \_ The collection and disposal of storm water;
- \_ Waterproofing and integration of membranes with tiles and canals;
- \_ The internal paint work;
- \_ The cleaning, consolidation and the veiling of the plaster;
- \_ The restoration of the archway decorated including the contour's band on the walls
- \_ The layout of the patio and the courts.
- \_ The construction of raised platforms with iron structures and wooden plank
- \_ The creation of a green house bioclimatic
- \_ The construction of an access path from the tower collapsed

### RESTORED FRESCOES

The castle is decorated with a cycle of baroque frescoes documenting a significant iconographic program with subjects drawn from mythology, history and literature that are intertwined to the history and lives of the feudal lords, and is a rare example, extended to almost all the main floor, survived in feudal residences of Salento. The pictorial decorations now in advanced stages of restoration are attributable to the brothers Nicola and Francesco d'Amore and have been built since 1694, as documented by the date placed under a painted scene with the alleged author's signature, (are few clear letters that should be investigated with subsequent essays), and was designed to celebrate the social success of the clients who had purchased the feud in 1643; for a correct interpretation of the scenes – as was the custom at the time - are explained with captions stipulated by the customer in very refined triplets documenting the culture and the poetic vein of the feudal lord.

For the frescoes were made the following processes:

- \_ The preliminary operations to consolidate and cleaning with removal of surface deposits inconsistent dry.
- \_ The Discialbo mechanical and / or chemical decorations.
- \_ The pre-consolidation of the paint layer or delamination of all surfaces.
- \_ The cleanup aimed removal of any repainting considered incongruous and no evidence of historical or artistic value.
- \_ The filling of gaps and injury has been made with lime mortar.
- \_ The intervention of resubmission aesthetic of the gaps and abrasions of the paint film with haze of color to watercolor.
- \_ For the stucco, the reconstruction of parts of the decorations simple and linear pads thinner.
- \_ The review of the chromatic rebuilt parts.

The stuccos reliefs and within the scale are currently under dull, the goal is aimed at the conservation of materials, original finishes and compensation of the gaps of the modeled in stucco. The project will consist of the removal of the layers, leveling and painting, the transaction provides for the preservation of the original finish of molded in relief.







### ARCHAEOLOGICAL FIND

The investigations conducted on the ground floor of the Castle of the Prince of Love, showed the remains of a manor, probably of Norman age. The fortified building may have developed from a settlement of the type "motta". The upper part of the greenhouse, on which was built the manor, has been, since ancient times, the perfect place for a defensive settlement. The "motta" initial Ugento, was to be formed by the circular tower and a defensive system that at present cannot be defined. At a later stage, the "motta" must have turned into a real fortified castle, although not extraordinary in size, because of the limited space on the morphology of the area.

The excavations, are allocated on the ground floor of the Castle, where he was made a preliminary removal of the floor original. Among the most interesting masonry of the most important it is represented by circular tower. The round tower was built with blocks, probably recovered from the Messapian walls of the city, later linked with mortar. The towered structure consists of seven courses of blocks all reworked were constructed with precision. According to what emerged from the excavations, the round tower was built directly on the rock geological to have strong and stable foundations. In the lower part, the masonry was damaged and repaired old.

In the northeast, there was a structure in connection with the walls: it could be a second tower polygonal. Next to it was built a monumental entrance consists of a vaulted room. The tower is the core of the investigation, probably, in phase with the first plant, in the Norman period. The circular tower is on an interior wall that connects the north tower (between the environment 7 and the environment 8) and which has an arch, perhaps representative, in opera finished.

After the Norman step, there is a further phase of settlement. The castle was enlarged with structures apparently poorer both in the south-east (room 6) and in the north (room 8), made up of stones associated with bolus.

At the end of 1500, the castle was completely rebuilt; the medieval structures, providing a stable and strong support base, are incorporated and not destroyed. The Norman castle is underground and lined by plants renaissance. In the north, in all likelihood, to the towers and to the walls lean against the existing tanks, underground today; above these last, it is the built up.

During excavations in some circles have been discovered well-preserved pottery fragments, sometimes even almost completely intact or reconstructed vessels, bronze artifacts, among which a button, and several other fragments as some plaques metal.



Renzo Bozzi  
Roberta L. Bianchini  
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## CULTURAL HERITAGE CONSERVATION IN LEBANON. THE CASE STUDY OF SAIDA LAND CASTLE



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Performing restoration works abroad as a company and not only as consultants was an opportunity offered by CHUD project, implemented by the Council for Development and Reconstruction of Lebanese Government. The objectives of the Cultural Heritage and Urban Development (CHUD) Project for Lebanon are: (a) to create the conditions for increased local economic development and enhanced quality of life in the historic centers of five main secondary cities; and (b) to improve the conservation and management of Lebanon's built cultural heritage. Therefore, this project foresees interventions on archaeological and restoration field that our company liked to seize.

Cooperativa Archeologia acquired and is currently performing conservation works in Saida Land Castle and Tripoli Esendemir Mill, while in a J.V. with Italiana Costruzioni acquired a contract of conservation and valorization works in UNESCO archaeological sites of Tyre and Baalbek - Baalbek and Tyre Archaeological Project 2- that will start soon.

The works project of Saida, Tripoli, Baalbek and Tyre is financed by the Italian Ministry of Foreign Affairs, Italian Development Cooperation and is designed by the Italian group formed by Planarch Srl., BCD projects and Italtrend.

The difference between being there as consultants or performers of the works obviously is something not to be underestimated, and our presence as a company required a huge

Saida Land Castle  
from South-East



Italian restorers during cleaning and restoration tests' implementing



effort in organization and management.

Our cooperative opened a local branch and started up co-operations and subcontracts with Lebanese professionals, companies, and suppliers, getting a practical ability for working in this country.

Here will be briefly illustrated the Saida Land Castle's case study focusing on the direct experiences gained.

### THE CASE STUDY OF SAIDA LAND CASTLE

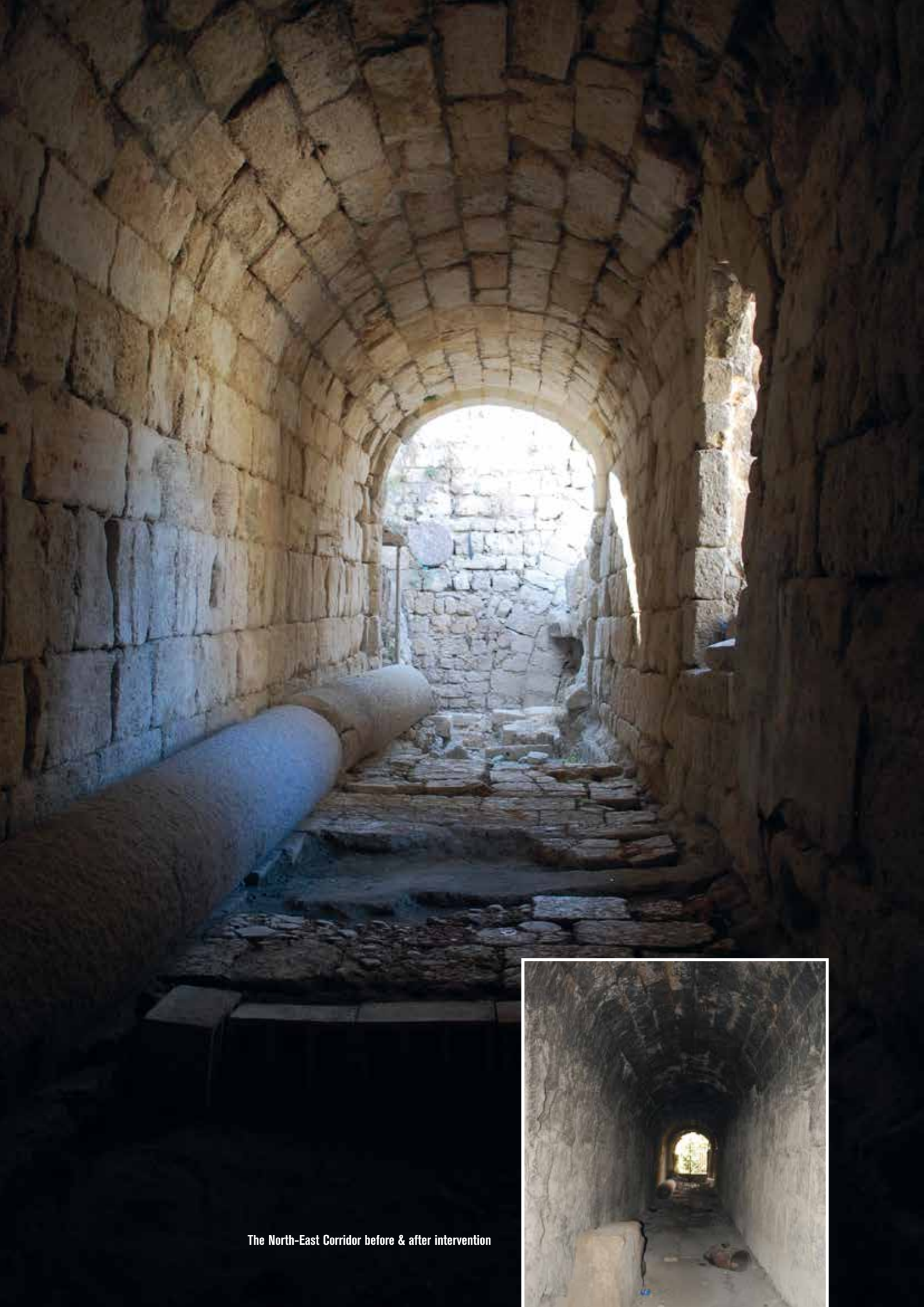
The city of Saida, known to be among the oldest cities of the Mediterranean basin, preserves an important nucleus of the old town, towards the sea, and was fortified by the famous Sea Castle to the north and, to the south end, by the Land Castle, until now excluded from the tourist circuit city and that was in precarious conditions.

The works in progress in Saida has involved a preliminary phase for study and tests that were implemented by Cooperativa Archeologia's staff. They set up methodologies and practices of intervention then transferred on subcontractor's company that is working under our technicians' continuous supervision.

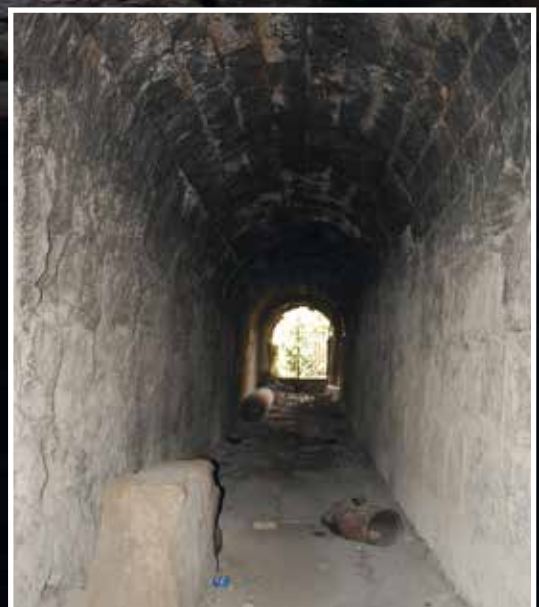
In that preliminary phase we detected local materials, suitable in order to get hydraulic mortars, using lime imported from Europe. Syria, a country more traditional and conservative than Lebanon about building practices, was a supplier of lime made through pre-industrial techniques, but the civil war occurred there obviously gets the import complicated. We tried to find in local markets those products necessary for cleaning and consolidation, minimizing importation of chemical products that is a very hard task.

The training of the local workers to the conservation's techniques has a crucial importance in order to complete successfully the expected works, in a border line between specialistic conservation and building restoration. This also corresponds to a more general aim of an initiative, funded by the Italian Cooperation, which is the dissemination of the principles and practices of the Italian restoration tradition.





The North-East Corridor before & after intervention



## ARCHAEOLOGICAL WORKS

As part of a wider project finalized to the conservation, rehabilitation and presentation of the whole Archaeological Site of Saida Land Castle, the Archaeological Investigation Project (AIP) has the following main scopes:

- \_ To assess the structural stability of the Castle's structures on the top of the hill, by means of investigations finalized to the understanding of the foundations' construction system and of their state of conservation.
- \_ To investigate the archaeological phases of the Castle and its supposed construction over ancient remains.

Although since the sixties of the last century has been suggested the presence of a Roman theater on which would have set the Castle in the Crusade and Ottoman period, widespread skepticism has dominated the debate and in the most complete survey on the Roman theaters in Italy and the Mediterranean basin - Frank Sear, *Roman Theatres. An Architectural Study*; Oxford University Press 2006- the remains of our site are not mentioned. In fact lacked a detailed archaeological and architectural study of the monument, which the restoration work and archaeological testing has provided a new opportunity. Although priority is given to the conservative intervention and restoration of the site's accessibility, the project included an excavation campaign aimed not only at the structural analysis of masonry but also to better understand the archaeological remains.

The restoration is an extraordinary opportunity, which unfortunately is not always caught, to get, beyond its conservation, a better knowledge of a multi-phase site.

Although here we focus on the methodological aspect of the archaeological analysis in a restoration intervention, the evidence obtained confirms the hypothesis that the Saida Land Castle is built on substantial remains of a Roman theater. It is probably the one built by Herod the Great in Saida, as reportedly by Josephus (AJ 15.8.1), in a context of Augustan culture that was spreading in the Near East.

## PRESENTATION, LANDSCAPING AND INFRASTRUCTURE PROJECT

The cultural objectives of the design are to offer the visitor of Saida Land Castle archaeological site an aesthetical significant experience and to provide him a better comprehension of the remains on the site.

New pathways are harmoniously set in the archaeological landscape according to the site features.

At the entrance of the site is built a new ticketing building, hosting the visitors, almost completed. Part of the monument, a long vaulted corridor belonging to the North-East gallery of the Roman theater, is dedicated to the exhibition of some archaeological finds discovered in the area, along with explanatory panels.

The discovery of remains of breccia corallina floor of Roman period in the North-East gallery is suggesting to review the project of new floor and the exhibition space and content that will prioritize the architectural elements of the theater and his hypothetical reconstruction.



## STRUCTURAL STRENGTHENING MEASURES

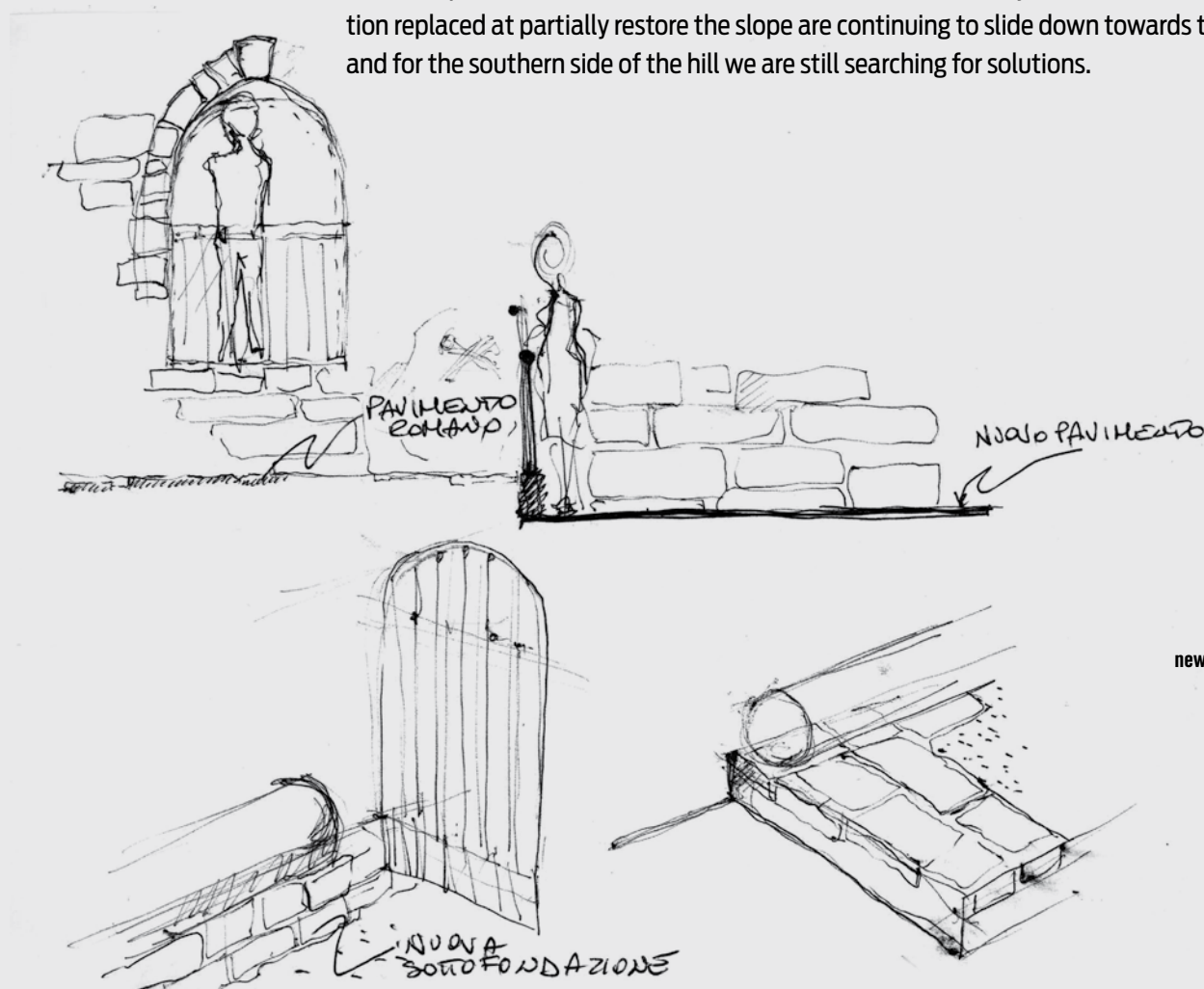
The project involved strengthening interventions by underpinning structures and reinforced soil technology to give support to the medieval walls of the castle, in addition to structural consolidations on the damaged structures.

The north-eastern tower, which in recent decades had lost the upper part showed deep cracks. They were then made the sub-foundation and a buttress wall; the cracks have been restored and inserted in the upper, internal part of the structure a galvanized steel plate.

In the south tower were restored major cracks and it has built a reinforcement structure on the northern side. It remains to implement the reinforced soil and the tie rods of aramid fibers in the upper part of the tower.

The replacement of stone elements in cases of gaps or serious degradation of the stones was carried out with the fundamental contribution of local workers, able to realize stone elements and put them in work with great skill.

In the Eastern and Southern side of the hill, we observe the most severe structural problems. In this area outside the castle and close to the perimeter wall the archaeological excavations of the last century, in the feverish search of the oldest structures, have deprived the walls of the support and undermined the static equilibrium, causing collapse of large sections of masonry and dangerous subsidence that are accentuated over the years. The historical photos show us the dramatic loss of medieval masonry. The debris of the excavation replaced at partially restore the slope are continuing to slide down towards the valley and for the southern side of the hill we are still searching for solutions.



## CONSERVATION OF SURFACES

Conservation measures are finalized to rehabilitate the main surfaces of the castle. This kind of work, set after previous mapping, samples and tests, concerns a procedure including different phases and operations:

- \_ removal of vegetation and biological attack;
- \_ removal of deposits and encrustations;
- \_ removal of improper joints;
- \_ grouting;
- \_ final consolidation applying chemical products on the surfaces.

The walls are made of local sandstone blocks, and given the site's proximity to the sea there is evidence of erosion and alveolization.

The castle was used as a stronghold during the civil war and there are evident damage of the improper use of the monument. In particular in the North-East prospect are portions of walls with traces of burning and inside the North-East gallery tires were burned for a long time and the combustion fumes have accumulated on the wall surfaces, tenaciously adhering to the walls.

The restoration was preceded by a series of tests to determine the correct method of elimination of the black crusts. During this phase, it has emerged portions of plaster, presumably of the Roman period.

Various techniques have been used for cleaning, from simple washing with water to the use of ammonium carbonate poultice and microsandblaster. Where the previous methods were not effective hydrosandblaster at low pressure was used with inert of similar hardness to the sandstone.

Inside the gallery, after the first stages of restoration, has emerged an extended biological attack, probably due to lack of waterproofing. For this reason, it was decided to expose the top surface of the vault and to create a waterproofing system with drainage pipes that fall away rainwater.

Lebanese worker  
implementing removal  
of biological attack  
on stone surfaces



Lebanese workers digging on the top surface  
of the North-East gallery vault





Anna Claudia Cicognani  
Elisabetta Pizzari  
Francesco Maria Peron  
Roberta Baldassari

## MERCATO COPERTO OF RAVENNA: THE ARCHAEOLOGICAL SURVEY AND THE REUSE PROJECT



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The Mercato Coperto of Ravenna reuse Project, historical and cultural heritage of the city, aims to the functional requalification of the interior of the property, entrusted by Ravenna to Coop Adriatica, in respect of the historical and artistic features of the building.

The new Mercato Coperto will offer to the old town an innovative space dedicated to culinary excellence and culture, a place that can regenerate and recreate the urbancity center in respect of the historical structure of the building, an heritage to preserve, appreciate and relive, where the innovative fulcrum of aggregation and identity will be food, chosen among a wide selection of excellent local products.

The intervention project design, signed Arch. Paolo Lucchetta, provides the opening of a new entrance on Via Cavour "which helps to create an urban inside route in continuity with the Mercato" and a distribution of uses on two levels:

on the ground Floor will found place an ice cream / chocolate shop, a Coop supermarket, a place dedicated to the craft beer production, dining facilities, Fresh Market, a Cooplibrary; on the first floor will be located space for cultural events and activities, a space cafe/ bookstore, an area for restaurants and a cooking school.

Today it is in progress the phase relative to the archaeological survey, that is propaedeutics to the final design and the structural intervention; the excavation surveys below the pavement share have unearthed the structural remains of buildings demolished at the beginning of the twentieth century to make way to the Mercato Coperto. It is archaeological structures related to a period from the Venetian dominion of the city (XV century) and the first years of the '900.

Coverage of the  
river Padenna of  
the XV century; partially  
collapsed. Seen by North



Coverage of the river Padenna of the XV century.  
Seen by South. We clearly seen as the vault has been used  
as support for the construction of building  
and floor structures of following epochs.





Panning from the top of  
the excavation yard

Extremely interesting is the discovery of large traits of Padenna tombamento coverage, an ancient river of Ravenna of which we have news since Roman times, whose tombatura probably dates from the late fifteenth century to the Venetian era, earlier found in Piazza Andrea Costa concurrently with the work on the project of underground drop Island, executed in 2009 by Hera SpA. The recovered structures are in progress of investigation with stratigraphical method under the scientific direction of the Superintendence Archaeology of the Emilia Romagna. In these days the archaeologists are at work to understand and identify the chronological phases of frequentation of the area through the analysis of the ground layers, of the masonries, their foundations and of the share. The graphic documentation is effected through the photogrammetric method and the restitution of the topographical relief is georeferenced on the interactive digital paper of the province of Ravenna. The photo-reliefs of the masonries and the recovered layers are realized, of time in time, corrected and georeferenced inside the encoded topographical base in the GIS. The photographic crawls are performed in a perpendicular way to the same distance in comparison to the plan of the objective. Some aims are positioned in the vertexes of the area to document, creating square that will be the photographic releases. The points of the aims and the relative quotas are then acquire through the topographical (a total station) tool.

The images are then subsequently straighten and climbed on together in an ortophotomosaic through the use of softwares devoted for the geometric correction. The following and final phase is the sketch in scale of the planimetries, façade and sections.

The use of the Geographical Informative System is fundamental for easily interfacing the



topographical data with the quantitative and qualitative information of the excavation area and to match or divide in different phases or levels (layer) spatial and planimetric data. These methodologies adopted on the site notably reduce the times of documentation in the yard returning a datum of high quality. We are also proceeding with a first spot-dates offragmentsceramicspicked in the stratigraphies, important to date the frequentation and the type of referencecontext. Inside the filling layers of the area and the topping of the structures, there are in fact numerous small ceramics fragments: dishes and majolica jugs, enamel and decorated, basins of terracotta, glazed, painted and graffited, little olle and fire pots that testify the principal centuries of life of the XV and XVI century structure. Currently the work are still in progress, the pursuance of the excavations and of some wise of close examination with the elaboration of the documentation will allow to acquire new historical and archaeological information of thisimportant area of Ravenna and to understand the phases of construction activity from the XIV century up to the beginning of the '900, particularly up to 1922, year of inauguration of the Covered Market.



Line of imposing wall with direction North-south recovered in the trench E. This wall should probably belong to the more ancient building phase of the area. From the image the stratigraphy is clearly seen by the tall one to the lower part; the native bricks floor of the Mercato Coperto that it leans on the crest of the most ancient wall and on the right another wall of following phase with the relative foundation



Long stretch of wall with course North-south with different constructive phases recovered in the trench B. We well notice the small transversal walls that divided the environments inside the buildings.



Particular of the trench B that well visualizes well the different building phases in the centuries of these structures

Brick floor rests recovered in the trench B referable to one of the modern phases precedents to the construction of the Mercato Coperto.







Alessandro Zanini  
Laura Bartoli

## LASER CLEANING OF CULTURAL HERITAGE



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Laser ablation is one of the most important irradiation effect which can be induced on optically absorbing materials. Laser cleaning is a particular case of laser ablation where a specific substrate is uncovered through the removal of undesired layers.

The application of laser cleaning in the conservation of artworks was proposed by J.F. Asmus and L. Lazzerini since the beginning of seventies through a set of practical tests carried out in Venice on encrusted stone artefacts: the novel approach, though, did not overcome the experimental stage for several years mainly because of the technological limits of the pulsed laser sources available at that time. During the eighties the technological level of the laser devices increased significantly but the costs were still out of scale for the specific field of application.

Since the second half of the 1980s laser cleaning was widely applied in stone artifacts restoration in Italy, France, England, Portugal, Austria and other countries, mainly for the removal of black crusts produced by environmental pollution but also for the removal of intentional dark layers applied in the past. Laser cleaning was applied massively on restoration of stone reliefs, historical façades, ancient archaeological artworks such as the West Frieze of the Parthenon and famous Renaissance masterpieces such as Profeta Abacuc, San Marco and Pulpito by Donatello, panels of the Giotto's tower of the Florence Cathedral by Andrea Pisano, San Filippo and Santi Quattro Coronati by Nanni di Banco, Fonte Gaia in Siena by Jacopo della Quercia, the capitals of the leaning Tower and of the Cathedral in Pisa and many others. This extensive application of laser cleaning was accompanied by basic studies on the phenomenological characterization of irradiation effects, diagnostic of the material removal and physical modelling which allowed the definition of operative fluence ranges ensuring discrimination between encrustation to be removed and the substrate to be preserved.

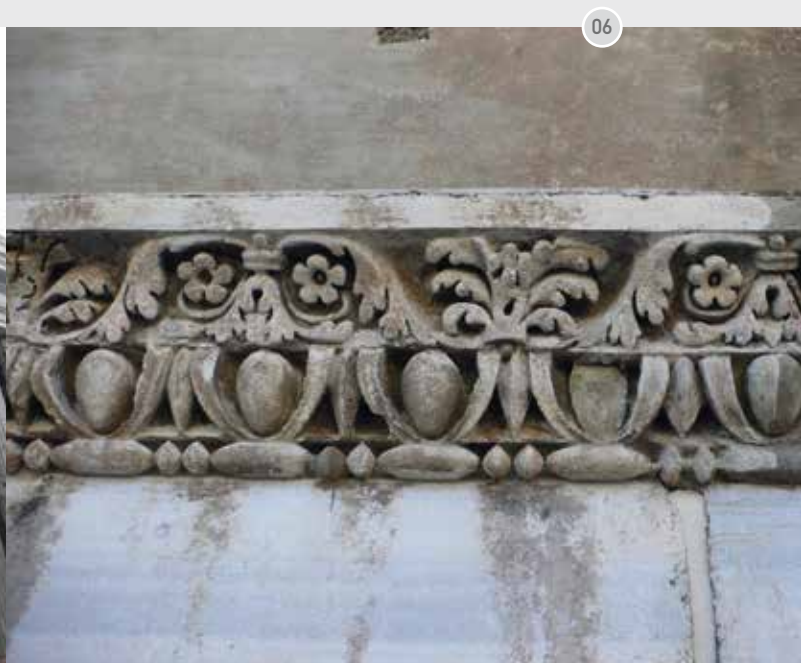
Laser ablation provides indeed many advantages with respect to mechanical and chemical methods in terms of gradualness, self-termination, selectivity and environmental impact. Laser cleaning of stone is the main application of the method: the black crust is easily removed by the stone substrate without any damage. The laser, thanks to its gradualness and selectivity, is also able to preserve the “age patina” that can be found on most of ancient stone artworks. A clear example is the laser cleaning of the Diocletian Palace in Split (Croatia). The Diocletian Palace was built by the Roman Emperor Diocletian at the turn of the fourth century AD. The perystyle is located in the central part of the palace and has been built using the calcareous stone extracted from Brazza Island nearby. The main part of the calcareous stones constituting the peristyle were covered by a quite thick black crust (from 0.5 to 10 mm) made of gypsum and carbon. A SFR laser (Short Free Running) with pulse duration of 50-100us was used for the cleaning. For thin crusts of 0.5 mm a fluence of about 13





J/cm<sup>2</sup> was sufficient for the removal, while with crusts of 2 mm it was necessary to increase the fluence up to about 22 J/cm<sup>2</sup>. For thicker crusts a mechanical removal was used to reduce the thickness of the encrustation: the finishing of the cleaning was performed always by laser because of its capability to safeguard the patina on top of the stone (fig. 1 and 2). An interesting example of laser cleaning of archaeological artworks is represented by the statues of the Dioscuri of Locri, a splendid group belonging to a Doric temple of 450-425 BC, executed in Parian marble, probably in Magna Graecia workshop. Very thick incrustations of different nature and morphology, present on the front side of the dioscuro named A, needed to be removed. These carbonate deposits partially incorporated earthy material coming from the archaeological sediment and showed an irregular dark ochre hue. With the use of a short pulse laser (LQS) it was possible to get a very good removal of the concretion, lightening the chromatic tone of the complex, without affecting the original patina of the marble (fig. 3 and 4).

The Temple of Hadrian erected in 145 AC is a temple to the deified Hadrian on the Campus Martius in Rome, Italy. The Temple retains eleven of the thirteen Corinthian columns of the north side, part of the entablature and the cella wall. On the marble two layers of film had been identified. The oldest, lighter and thinner, is organic and made from casein of goat milk and egg white. The second, much thicker and of brown-black color is a true dyeing, wherein a mixed animal glue of rabbit and pig origin was identified. The laser was able to remove the dark patina without attacking the light, oldest patina lying beneath, and without damaging the marble. Despite these good results, it was decided to keep both oxalate films for consistency with the intervention performed in the 80s on the free columns of the arcades. The laser was applied to give continuity to the architrave, which is a particularly damaged architectural element. The most recent patina, which in-



interrupted the flat elements with alternating black stripes, and almost completely flattened ovoid shape of the reliefs has been removed or reduced (fig. 5 and 6).

The application of laser cleaning on wall paintings concretely started with the case study of Santa Maria della Scala frescoes in Siena. The Old Sacristy and the Chapel of the Mantle are two painted halls within the complex of Santa Maria della Scala in Siena. One of the oldest European hospitals opened about 1000 years ago and functioning until 70 years ago, Santa Maria della Scala has been gradually turned into a museum. The walls and the vaults of the Old Sacristy were painted by Lorenzo Vecchietta between 1446 and 1449 with scenes from the Old and New Testaments. The paintings were coated with layers of whitewashing applied in the past. Used as first-aid room, the Chapel of the Mantle shows three spans divided into groin vaults painted by Cristoforo di Bindoccio and Meo di Pero in 1370. Again, in the past the paintings had been almost completely covered with layers of lime and paint whitewashing. When the traditional chemical and manual techniques proved unsuccessful, restorers thought about the groundbreaking use of lasers. Preliminary tests were carried out with a Short Free Running system (Eos 1000) and the Long Q-switching one (Eos 1000 LQS). These two intermediate-impulse systems proved extremely effective and safe compared to short-pulse Q switch lasers; used together or one by one, they resulted in the successful removal of the whitewashing, revealing the frescoes resting underneath.

After the successful cleaning in Siena, the laser started to be used also on extreme environments such as catacombs. One interesting example is the cleaning of the wall paintings in the “Baker’s niche” in the Domitilla’s catacombs in Rome. The bakers’ niche is located on the first floor of the catacombs of Domitilla. Its walls are mainly frescoed, often with dry overpainting. The microclimate inside the hypogean structures of the catacombs is usually quite stable, featuring high relative humidity between 96% and 100%, and temperatures around 14-17°C all through the year. One of the most common decay problems concerns the precipitation and crystallization of calcium carbonate that covers the frescoes almost entirely. An instance of such decay is the typical dark film covering the vaults and the upper walls of the rooms that may range from thin films to very thick layers. During the last twenty years, the removal of incrustations has been carried out mostly manually, trying to remove the most of the concretion, at the same time protecting the original painting. Nevertheless, the results obtained with this method were unsatisfactory as they did not result in the complete cleaning of the surface. Thanks to the laser the dark film was completely removed from all the shades of colors (white, green, ochre, etc) and the wall paintings were completely uncovered by the black layer that concealed them (fig. 7).

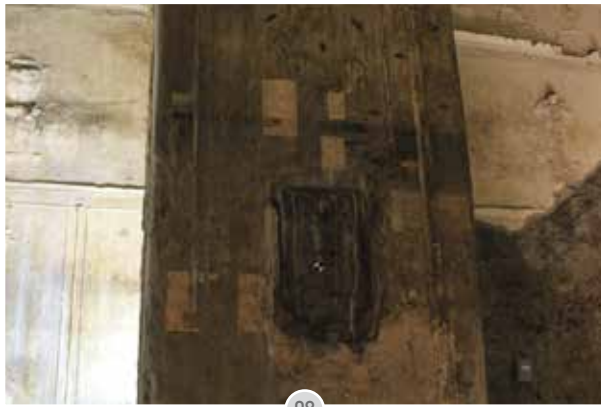
Another example of successful laser cleaning in hypogean environment is the cleaning of the decorated stuccoes of the vault of the Pythagorean Basilica of Porta Maggiore in Rome. The Basilica was built underground between 14 and 54 AD and was used for meetings of Neopythagoreans. The ground plan shows a basilica with three naves and an apse similarly to early Christian basilicas that appeared only much later in the 4th century. The vaults are decorated with white stuccoes symbolizing Neopythagorean beliefs but whose exact meaning remains a subject of debate. The stuccoes in the vault were covered by a thick and











08



09



10

strong layer of calcium carbonate whereas the decorations on the walls were covered by earthy residues. A powerful QS laser was used to safely remove the encrustations bringing back to light the delicate decorative motifs (fig. 8).

The application of laser cleaning on metals concretely started with the case study of the gilded bronze panels of the “Gates of Paradise” by Lorenzo Ghiberti of the Baptistery in Florence: a careful optimization of laser parameters was performed and led to the introduction a Long Q-switching laser system with pulse duration of 100 ns. The effectiveness and safety of the laser for the cleaning of amalgam gilding, gold laminas, silver and related alloys were proved during the years thanks to interesting conservation treatments such as, in addition to the already-mentioned Gates of Paradise, the restoration of the bronzes statues of David by Verrocchio, David and Attys by Donatello, and the successful cleaning of a Roman Hoard composed by 300 silver alloy coins.

A complex project has been the intervention on one of the most well-known among the great Etruscan bronzes, the so-called “Arringatore” (the Orator), a votive statue that was found in XVI century near the Lake Trasimeno in Middle Italy and became part of the collection of Cosimo I de’ Medici in 1566. The statue, 1,79 m tall, cast by lost-wax technique, is composed of seven distinct parts welded together. Supposedly, the statue underwent several undocumented restoration and maintenance works along the centuries. A SFR laser treatment was carried out for removing a brown-black patination applied in the past. The unwanted patination was an organic-matrix layer of some hundreds microns including silicates, calcite, gypsum and a pigment load of carbon black and ochres, along with sporadic presence of Ca- and Cu-oxalates deriving from the mineralization of the binder. Water assisted SFR Nd:YAG laser irradiation at 2J/cm<sup>2</sup> fluence was used to partially ablate and thermally disaggregate the organic-matrix patination: the cleaning was then mechanically finished using scalpel and brush. The recovery of the surface readability was evident as well as the tenorite black layer intimately bond to the metal surface. The laser was used also to remove undesired incoherent copper minerals after mechanical cleaning: the SFR laser irradiation at low fluences allowed a deeper degree of cleaning with respect to mechanical finishing and then allowed one to control the final chromatic hue of the surface uncovered (fig. 9 and 10).



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## RESTORATION AND SEISMIC IMPROVEMENT OF RESIDENTIAL COMPLEX “PORTA NAPOLI” L’AQUILA (ITALY)

Building bound by Architectural Heritage protection (D.Lgs 42/04)

This complex of 5 buildings represents one of the first examples of “social housing” in Italy, and for this reason it is protected as Historical Architectural Heritage. This compound was built by INCIS (*National Institute for Government Employees Houses*) around 1925-1930 to host government employees and their families.



These historical buildings have been heavily damaged by the earthquake that hit the region of Abruzzo (central Italy) on April 2009, rated 5.8 on the Richter scale, making them uninhabitable unless extensive and substantial restoration.

Main seismic vulnerability of the buildings was the poor quality of stone masonries, due to roughly-shaped stones, frequently undersized, and low consistency mortar, occasionally applied with undue thickness to compensate stones irregularity.







The aim of the restoration intervention was either a static consolidation and the seismic improvement of the buildings, achieved by reducing the causes of seismic vulnerability. The intervention was designed on one side to increase walls mechanical strength, in order to make them able to suitably absorb combined shear, compression and bending stresses typically induced by seismic action, on other side to optimize the structural response of the whole building.





Design strategy was first to repair all items damaged by the earthquake in order to restore original situation, and then to proceed with a global consolidation of the structures, to achieve the seismic improvements level required, and to increase ultimate strength and ductility of the buildings.

Masonry walls consolidation have been achieved through the “reinforced plaster” method, i.e. the application of Fibre Net glass fiber mesh on both faces, connected transversely by mean of FRP connectors, and fixed by mean of a thin (3-4cm) plaster layer.

Thanks to FRP absence of corrosion, mortar was lime-based type, ensuring the best compatibility with the existing masonry, good breathability and resistance.

The use of composite materials instead of steel assure long term durability and a reduced alteration of walls overall stiffness (inflexibility).

The intervention was extended to all internal and external walls, either stone and bricks ones, at all levels of the building. Consolidation job was completed at the end of 2012 achieving, and often going beyond, expected improvements.

At the moment construction site is in the final stage to perform last finishing.

Caterina Giovannini

Article based on:

"Scuola di Restauro – Heritage Conservation  
in Italy and in Russia";

curated by N. Berlucchi, D. Fiorani,

A. Grilletto, S. Kulikov, O. Pyatkina,

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Malta,  
view of Valletta

## THE MALTA SITE. CLEANING.

### Controlled air-abrasion with IBIX technology. Respect of the patinas and uniform cleaning

Situated in the proximity of Italy, North Africa and Greece, Malta has always been a cross-roads of peoples. Since ancient times, the great civilizations having played a dominant role in the Mediterranean region have claimed possession of the island. Before its independence in the 1970s, Malta has lied under the influence of the Greeks and the Romans, then was dominated by the Arabs, Byzantines and the Kingdom of Sicily up to modern times, when the island was conquered first by the French and then by the British.

Given its strategic position, Malta has always been a contested territory. Therefore, build imposing defence infrastructure was needed. The first fortifications were raised in the Middle Ages to ward off an invasion by the Arabs who had ruled over the island until the 11th century. Further and massive fortification works were started by the Knights Hospitaller during the 16th century, after successfully resisting the siege by the Ottoman Empire. With the British occupation of the island, the ancient infrastructure was restored, extended and renovated to meet the military needs of the second world war.

Since then, no major restoration interventions have been carried out on Malta's historic walls. Over the past few years, thanks to European funds, the Maltese archipelago has been subject to a restoration campaign involving the most ancient and prestigious sites of the island, such as the Valletta and Medina fortifications and the Birgu walls.

The funds have contributed to raise in the Country the deepest awareness regarding restoration, thus addressing the lack of a true culture of conservation in the island so far. The Maltese government has immediately identified Italy as the reference model to properly





plan the renovation interventions and, thanks to the creation of an Italy-inspired Superintendence-based system, they were able to achieve extraordinary results in little time. The Maltese authorities have joined a project of cultural exchange with our Country in order to learn how to master architectural and stone restoration and conservation techniques.

The EU prerequisites were the guarantee of excellent results and the implementation on the Maltese territory of specific facilities dedicated to the conservation and restoration of artwork, in order to encourage the transfer of technical knowledge and know-how from Italian experts to local technicians. The Polidano Group, the Maltese company which usually deals with the construction of infrastructure, was awarded the tender contract for the conservation works of the walls of Birgu, on condition that they cooperated with an Italian restoration firm. The first stage of works on site consisted in pre-intervention analysis, through preliminary testing and surveys to identify the best operative method and to acquire as much information possible on the surfaces and their state of conservation.

Analysis were implemented using, among other tools, the IBIX MOBILE LAB, a fully-equipped portable laboratory which allows to carry out diagnostic surveys on historical building materials directly on site, and to get a precise classification of the natural and artificial stone materials and relative degradation. It is an essential tool that can provide validated parameters for intervention in a simple and inexpensive way, according to a scientifically-based approach to restoration work thus putting an end to what Dezzi Bardeschi used to define as *"The romantic figure of an inspired technician electing himself as sole judge of the monument on which to intervene"*<sup>1</sup>.

The analysis carried out determined the conditions of the surfaces by means of a series of parameters being measured: moisture, quantity of salts present in the materials and their classification. The possibility to carry out multiple on-site surveys with limited costs and skipping the usual lab waiting time, has been a tremendous advantage in the execution of the intervention.

As a matter of fact, the walls presented completely different characteristics based on their location and only correct measuring of the reference parameters could have provided the

<sup>1</sup> M. Dezzi Bardeschi, *Restauro: punto a capo*, 1991

#### The Site



Mechanical Damage



Pitting of the surface

Biological infiltrations



IBIX Mobile Lab



needed information to decide on the proper conservation approach. For example, the exposure to weather conditions, wind and sea air rich in salt produced a characteristic concentration of chlorides which was found to be significantly lower in inland areas. In this case, having divided the site in different areas for measuring has led to the acquisition of precise knowledge on the degradation phenomena – chemical, physical and biological – thus enabling planning of an accurate intervention project.

Another fundamental aspect involved in the determination of the conservation approach was the type of stone on which the intervention was to be carried out. Indeed, the Malta stone features characteristics which are unique in the world. Similar to the Lecce stone, the Malta stone is a Miocene limestone (21 million years ago): its specific components lend it unique compactness, colour and structure. The presence of fossil fragments gives the stone further appeal and geological value. The types classified differ in colour, homogeneity, compactness and age.

Fully aware that cleaning is probably the most delicate phase in the conservation cycle, as it is irreversible, minimally-invasive techniques are to be preferred in order to best preserve the artefact. In fact, the wrong intervention could cause irreparable damage to the artefact, accelerating the degradation process and causing the loss of material essential to the understanding of the history of the artefact. Cultural objects are unique and irre-



placeable, made of unique materials for which no standard method is adequate. Each cleaning intervention must be carefully planned, on the basis of deep diagnostic analysis and preliminary cleaning testing to identify the best cleaning techniques for each specific case. Indeed, in compliance with the legislation, “The materials and processes to be used must be chosen based on the results of necessary assessment carried out by qualified and industry-specialised laboratories to determine the effectiveness and/or any side effects”<sup>2</sup>. All the different analyses carried out on the Malta stone, under the supervision of the local superintendence, have identified only two possible viable cleaning processes: manual cleaning with broomcorn brushes following treatment with chemical agents or selective cleaning with micro-air-abrasion system with helical vortex nozzle by IBIX. Any process involving the use of water during cleaning was categorically excluded.

The outcomes of the preliminary tests and previous knowledge on the Malta stone - its characteristics and damage - have led to the choice of cleaning through IBIX air-abrasion systems, taking into consideration the enormous amount of time saved and, as a consequence, the reduction of labour costs. Furthermore, an higher safety and uniformity of the intervention was guaranteed by the possibility to “customize” the system functioning parameters of working pressure (as low as 0.1 bar), nozzle size (as little as 0.8 mm), grain size of the abrasive material (as small as 38 micron), flow type (vertical or tangential) etc.

HELIX® is a special gun able to give a rotatory motion to the abrasive exiting the micro sandblasters. This exclusive IBIX patent has been developed and produced in Italy. Thanks to this special technology the impact of the abrasive on the surface is not vertical but tangential, so that the abrasion is more gentle and respectful of the treated surface, increasing at the same time the contact area and the machine effectiveness. The HELIX® system offers, for the same nozzle dimensions, an increased tangential contact area, maintaining

<sup>2</sup> Uni Beni Culturali 11182:2006



The Malta stone

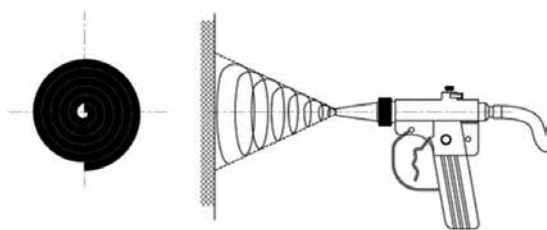
Restoration, removal of black crusts and salt efflorescences with HELIX® air-abrasion technology

a uniform and calibrated action of the aggregates on a given surface: this makes it possible to increase the distance of the operator from the treated surface, minimising invasiveness without losing the regularity and evenness of cleaning.

In the Birgu site, the dry HELIX® equipment was used with calcium carbonate based aggregates of extremely fine grain size in order to remove dirt residues, particularly stubborn “black crusts” and salt efflorescences. The material, which is the main component of marble and limestone, is 100% compatible with porous stones allowing for a gentle, yet effective, cleaning also on delicate materials such as the Malta stone. The aero-abrasive machines were set at best based on the data collected with previous analysis: thus, the working pressure and quantity of abrasive exiting the gun were adjusted to the specificities of the area being treated.

The outcomes were excellent and met the expectations for the intervention. The use of the HELIX® system ensured low running costs and labour savings, reduced strain on the operators and cut off the duration of the works, all while respecting the absolute ban on the use of water. Cleaning, in line with the technical tests carried out, was uniform and matched the colour of the original stone. Especially in those areas which are less exposed to weathering, the historical patina was perfectly preserved and even enhanced by the elimination of unwanted deposited material, both of chemical and biological origin.

In conclusion, the restoration intervention was fully successful, entirely meeting the expectation of the Maltese safeguarding authorities. However, the importance of the project has gone beyond restoring the original beauty of the Walls of Malta: further grounds for satisfaction lied in the fruitful cooperation among all the subjects involved in the intervention. With regards to the goals of the European tender, the project has left Malta something more than the beauty of its monuments, transferring precious working know-how and a newly-found awareness for restoration and conservation issues to local operators.



The Helix® principle



The cleaning



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## MAINTENANCE RESTORATION IN THE ARCHAEOLOGICAL AREA OF POMPEI

The construction site is a phase, the more delicate, the greater the flow of people / visitors affecting the area as in the case of the excavation site of Pompeii has always fixed destination of thousands of tourists. Therefore the organization of the shipyard for maintenance work at the Archaeological Site of Pompeii was conceived as: construction of knowledge that comes to restoration site. As jobs have the entire area and the Archaeological work will be located in various regions the goals the company has set itself to pursue the preliminary works of the different areas requiring intervention were: FRUITION environments including in the construction site; INFORMATION concerning action to take, given the importance of the site; DECOR spaces in the conduct of their work. The goal was to restore the visitors a part of the knowledge related to the well temporarily not accessible at the time of the construction site. This allowed us to understand the significance of the many construction sites located on the site, which often can risk being perceived as an inconvenience, rather than the outcome of an ongoing commitment to the protection of the asset. The goal was to try to explain what happens "behind the scaffolding." You have chosen to use clear language and which provided essential information scientifically correct, but at the same time understandable to a non-expert in matters of consolidation / restoration. The company then offered two different ways of using the areas requiring intervention: • a tour of the areas through web pages, uploaded to Totem, with a group keyboard-trackball, to be installed in the vicinity of the most significant, various entrances to the ruins (Amphitheatre Square, Piazza Esedra, Port Gate) area ticket office, refreshments etc, on which organized photographic material that allowed to grasp the different details of the operation; an overall view of the site of the first phase of the construction site, and during one of the next stage of completion. • A second mode of communication made to coincide with



Attic floor wooden



Restoration with full cover bering structure walls

the first was to create a paper document, a brochure, agreed with the works team, who led the visitor on its way to the excavations and the visit to the construction sites themselves, on which You have been given the information on the areas requiring intervention, the optimal routes. Considering that the intervention involved almost the entire area of Pompeii Archaeological, the company has decided to use 3 type teams, composed of 4 workers (1 skilled worker, journeyman 1, 2 workers from common support processes). The teams were supported by the presence of more tec', architect / surveyor or, on site during the performance of work with the task of looking after the success of the same.

As in the design phase was not decided any priority interventions, the firm adhered to from time to time as it was decided by the Directorate works to define the priorities of the operations done. Whenever it was prepared a service order, for the organization of the construction site, a company engineer went on site to become aware of the state of the site, preparing a brief report in which it was described the state of places, entering in the merits of the conditions of funding, the collection and / or disposal of storm water, the state of the walls, the lintels, the ammorsament, of the crack in general and any other element of compromise and responsible static conditions of the site object d'intervention.

The report was submitted to the Department, together with an action plan capable of restoring the house and / or the walls present in isolated site consolidated; and therefore capable under the static to resist efficiently to ordinary stress. They were also given further work (construction of curbs armed interposed between the facings of the walls, the carbon fibers in the layer of sacrifice on full walls and cant partial transverse walls) capable of structures to develop a seismic retrofit to the extent permitted by law regulations and circulars from the Ministry of Culture. Also the writer has put his availability, given the extent of the subject of intervention, identifying in accordance with the contracting, at least three main areas where the company has taken charge of creating group 3 Point site, ie in which three points were placed support services to the operators, such as cabins for the Conservation of work vehicles and equipment, for the rest of the

Remaking coverage  
with tiles





Restoration of  
reinforced concrete lintel





Cover with  
sheet Coverib



workers, toilets and offices for the technical operators, each of which is served as the basis of the subsequent building yards instead of constantly install and uninstall the preparations. The choice of the identification of these macro-areas was deemed strategically close to the areas of vehicle entrance to the excavations, so as to facilitate the workers during the procurement and storage of materials. The company also in the organization of the site area has prepared near fences / gates entrance of the main civic / environments, according to the shape of the areas of intervention, panels made with digital printing on PVC sheets, on which were reported splashes of color, drawings render pictures and will be have the advantage of resisting to atmospheric agents, so as to inform visitors and at the same time to decorate the yard so respecting the objectives originally cited. Handling as well as the supply of the material was always performed before the opening of the excavations has been closed to tourists or to ensure the safety of people, just as it is placed maximum attention to all those operations that could result in noise emissions. In many environments it was planned interventions of demolition and cuts structures, it is proposed in order to limit the noise to assess the need to apply the mitigation measures already only one action planning that took into account the busy periods of the excavations of the tourists or on a schedule designed to achieve the most significant in the early hours of arrival of the workers to the excavations. In the manual handling of the material, the company has taken charge of all expenses from any address to protect flooring, and has performed these operations with the aid of sand, PVC sheets and wooden plank protection. To protect the decorations of vertical partitions MobilCom used the use of valances, protection capable of causing damage or abrasions. The categories of interventions can be so summarily described:

- \_ demolition and reconstruction of the attic floor in a wooden supporting structure;
- \_ demolition and reconstruction roof joists, roof tiles and roof tiles;
- \_ construction of temporary roofs, with slabs Coverib;
- \_ demolition of attic floor in iron elements and a.c. and reconstruction in the attic with wooden support structure;



- \_ repair of floors in beams and slab, with reconstruction of the overlying waterproofing;
- \_ repair the wooden floors of coverage, with reconstruction of waterproofing;
- \_ revision and restoration of the top wall with special fiber-reinforced mortar and reuse elements lithoid original, with compensation on time with new elements tuffaceous blanks irregularly;
- \_ consolidation of lintels made of steel beams, with passivation treatment of the two or more beams that form the lintel after removing rust and cleaning sandblasting, protection using appropriate products and finishing with plaster protection for iron;
- \_ consolidation of lintels made from steel beams via substitution of one or all of the beams, and of the same size to be allocated in the same position;
- \_ consolidation of lintels constituted by reinforced concrete beam;
- \_ replacement of lintels with new laminated wood through the propping of the portion of the wall above 'lintel, the' extension manual compartment housing with the next slip-off and the 'inclusion of the new lintel of similar size to the previous one.
- \_ installation of temporary structures;
- \_ plastering of the joints, with raw materials as much as possible similar to the existing ones;
- \_ integration of shortcomings or gaps in the walls of portions facing walls of the equipment with installation of elements similar in shape, size, processing technique and installation compared to existing ones;
- \_ sarcitura detachments walls and injuries in the masonry.

In conjunction with these processes work they were carried out for the protection and consolidation of the mosaic floors, wall paintings and all of the decorations.

For roof coverings and flat roofs were used in solid chestnut beams. When the beams needed to the structure, presented sections out of print, the same were made by laminating together beams of the commercial section. Scrolling between them it has been absorbed by the interposition between the beams of thorns slip, shoeing any of the publications and the use of adhesives based on vinyl. Even for the replacement of the architraves was employed chestnut wood. When sections of wood have had the necessary sections out of trade for the type of essence or when the static situation has recommended the replacement of the lintel in two halves, the platbands of chestnut wood were realized with two beams emplaced juxtaposed other and connected with a plug longitudinal axis (wooden strip of strong essence) solidarised with adhesive on vinyl base .. This intervention was carried out to avoid the inevitable and unsightly reading of the connection between the beams, due to expansion associated with temperature variations and humidity. For the partial repair of the walls, it was built connecting the vestments that form the walls with bricks, and / or diatones masonry and / or tilting stainless steel To restore beams a.c. it was considered that the remedial work was identified in the treatment of armor with a mortar camentizia corrosion (after their cleaning), and reconstruction of concrete cover with fiber-reinforced mortar with controlled shrinkage. For waterproofing systems it has been used a sheath Paralon ARD / HS PLUS ST - bitumen membrane elastoplastomeric with armor in "non-woven" polyester filaments stabilized with fiberglass, thickness: 4 mm (Slater) cold flexibility : -20 ° C with the finish of the upper face with slate gray natural, red or green. For reinforcing bars provided in high ductility class technical B450C, complies

with the Technical Standards for Construction of 23/09/2005, it was proposed galvanizing bars. For the walls in general, in particular, when it was planned their implementation and / or raising leading to buttress the masonry piers higher, it was considered that the intervention was carried out with the construction of concrete armed cordoletti modest section 15x15 or 20x20 in the walls of banked. To the top wall in the phases of recovery, it is proposed to include in the masonry of sacrifice carbon fibers capable of improving the behavior of the male wall and / or confer a greater participation of the same to the resistance of the walls. In the building floors in wooden beams and overlying plank, it was carried out by inserting a network galvanized welded and overlying concrete slab lightened variable thickness, to make it work also as a boulder of the gradients. To restore beams, chains and iron clamps at the points where it was intended to conserve them, the same have been treated by brushing and cleaning scartavetratura and / or after use of paint strippers. The missing parts and / or impaired have been integrated with round or flat irons welded and stuccheggiati. The parts that may not be mechanical stress have been treated with rust converters. For interventions demolition of ceilings and lintels a.c. intervention can be achieved with the use of equipment (clipper) capable of avoiding vibrations and jolts to the walls and to the shell. For temporary works, while fulfilling the conditions of maximum security, it tried to avoid the construction of scaffolding pipes and joints and / or their stay in the long term. Alternatively rolling towers have been used and / or scaffolding at hair band all of the mobile type in order to avoid excessive shielding of the environments to public people. Le fences for building project, of a height not less than 2:00 am with wooden stakes or tubes from scaffolding and sheet galvanized corrugated have been improved for a less invasive with fences provisional modular panels in wood and metal for low-impact urban areas, prone to advertising fitting or designs from street furniture, with stiffeners and supporting poles made from galvanized metal tubes diameter not less than 40 mm braced, complete with blocks of concrete base by weight not less than 50 kg buried, connection terminals and elements hinged to the door module. It 'important to note that the works were carried out with the accuracy required both to ancient structures and to those' modern 'as it is now integrations' historicized' and being in solidarity with the construction.

Integrations of wall portions



Consolidation decorations





Giammarco Piacenti  
Silvia Starinieri

## THE RESTORATION OF THE NATIVITY CHURCH IN BETHLEHEM

• CENTRO RESTAURI •  
**Piacenti** S.p.a.  
conservazione di beni di interesse storico artistico

### Worksite, operative team and Restoration

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The Nativity Church in Bethlehem, In the last five years , has been the object of a project for its study and restoration. This could be realizable thanks to the relations between the three religious communities (Greek Orthodox, Armenian, and Franciscan) wich have specific rights and properties in the Church, regulate from the Status Quo. The uniqueness of the historical site and the importance of the project have considered a large phase of study and knowledge of the building construction and its component materials, and their conservation state. A document published in 2000 by UNESCO (WENZEL-SZAKTILLA-PLIETT 2000), underlines the poor state into which the roof of the church was and the resulting damages to the plasters, mosaics and floors, due to the rain.

The complete documentation that reported the total decay state of the Church, was composed during the project since 2010, by a multidisciplinary group coordinated by Consorzio Ferrara Ricerche (University of Ferrara).

On August 26, 2013 an agreement has been signed for the Restoration of the Church of by Piacenti S.p.a. – Italy as “Contractor”. The executive planning and the restoration intervention should have to regard the renovation of the physic and mechanical functions of the wooden trusses and boards system, the replacement of the lead sheets as external covering of the roof. After that the restoration operations affected also those Church’s areas in very bad conditions aesthetically and structurally:

- \_ the internal and external surfaces (plasters and stones)
- \_ the mosaics
- \_ the narthex
- \_ the main iron and wooden doors of the Church
- \_ the wooden architrave.









At the moment four skilled teams are working on site. The restorers are highly specialized and coordinated by a technical team situated in Bethlehem and in the Italian office.

Each material of the Church needs a special study, documentation and restoration treatment, and the worksite has to be arranged and coordinated every day with the maximum efficiency in order to respect the time-schedule and the restoration itself. The Contractor has a Local Partner as an important help and support for the logistic and materials finding issues. Many of the local workers, Palestinian workers, are involved in the arrangement of the worksite, and the relationship between the different roles and nationalities are increasingly positively surprising.

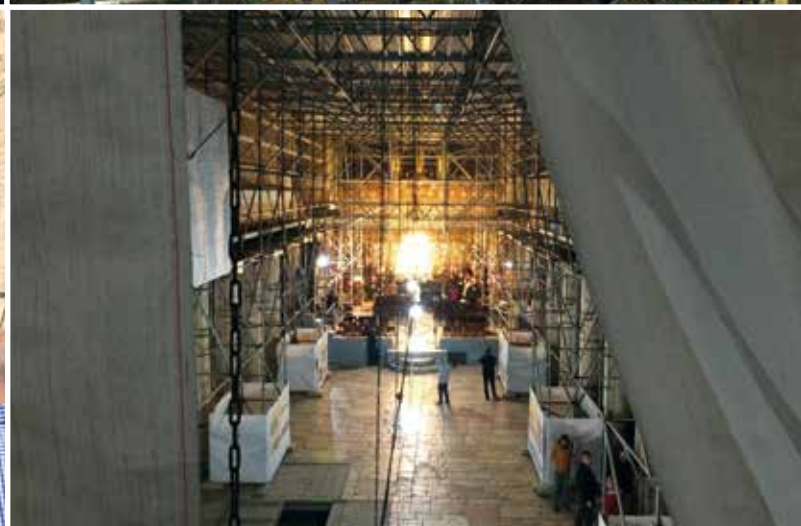
Many consultants and experts of the various fields of restoration, are involved in this work, the relief and survey of the building, the structural engineering, the diagnostic analysis, the history of art and the restoration. Each branch has a consultant, a project manager, a foreman and a team composed by skilled workers, all of them are followed and controlled from the technician team and from the site supervisors for the time, budget and art respect. This presentation aims to let to know how this worksite was studied, a worksite very difficult, in a delicate ambient as the Nativity Church, in the Palestinian territories.

All the work phases will be illustrated, starting from the project to the operative methodology that had united the traditional conservation of art and the new technologies for the restoration.

The study and the participation to the international tender needed a huge applicative obligation both to obtain a knowledge of the building and to the elaboration of the technical and economical offer. Those difficulties were surpassed, and the target acquired, thanks to the synergic work of the expert technicians coming from different sectors.

Each organizational, technical and economical aspect was examined in depth to limit











future possible unforeseen. Now, after three years, is possible to affirm that choose were provident.

After the contract sign, and after the minimum necessary time to the combination of the first team of work and the arrangement in Bethlehem, the preliminary phases were started. During the waiting for the scaffolding arrival (all the materials are imported from Italy through 30 shipment by containers, from Genova to Ashdod), the Church was investigated by a metric, material and photographic survey.

The structure of the scaffolding were designed and calculated by the engineers to obtain an ordinate and light asset, this to give full access to every area of the Church, without interferences during the religious activities. The scaffolding also allowed the shoot and visits by journalists and visitors interested at the work.

It is important to stress that each restoration process is always preceded by accurate diagnostic investigations, to assess the quality and the quantity of matter under examination. The restoration began with the renovation of the roof. 2000 square meters of surface were in a very bad state of conservation, and were restored by replacing old plates in lead, and creating an air chamber that would allow ventilation between the layers. The wooden beams and trusses under the roof, which contribute to the stability of the overall structure of the Basilica, were the subject of a high-tech restoration. The work followed a procedure designed and approved specifically for the type of structure and this wood, such as the replacement of deteriorated portions with prosthesis of the same old woody species. The study and restoration work continued towards the recovery of the wall surfaces, which show beautiful stones and old mortars (the original construction of Justinian), ancient plasters "fiber-reinforced", and completely original mosaics of exceptional craftsmanship. The team of experts for each sector followed the methodology in full compliance with the original materials and their historical context.

The products used are derived from the artistic tradition and experience to ensure a recovery of the works and to protect them in future.





# INTERNATIONAL PROJECTS

## IN PROGRESS...

**3<sup>RD</sup> - 10<sup>TH</sup>  
APRIL 2016**

**WORKSHOP ICE - ASSORESTAURO 2016  
ROME - FERRARA - MILAN**



### CONFERENCES IN FERRARA - 7<sup>TH</sup> APRIL

**Internationalization of Italian  
Firms in the sector of Restoration:  
case studies**

**GBC HB PROTOCOL.**  
LEED certification for Historical Buildings

### INVITED COUNTRIES

Turkey, Russia, Cuba, Iran, Armenia, Lebanon,  
Mexico, Chile, Brazil, Argentina



FERRARA FIERE

**R M** RESTAURO | MUSEI  
XXIII EDIZIONE

**FROM THE AUTUMN 2016 THE CENTRE  
WILL BE THE HEADQUARTER AND  
THE SYMBOL OF THE COOPERATION  
BETWEEN ITALY AND CUBA**

**Head organization:**  
MISE - ICE

**Executive Partners:**  
As sorestauro - Federigo arredo

**Cuba Partner :**  
OHC - Oficina del Historian or de L' Habana Vieja



CUBA

**TECHNOLOGICAL CENTRE FOR RESTORATION AND DESIGN  
CALLE DE SANT IGNAZIO HABANA VIERA**



# UNDER CONSTRUCTION...

PROMOTIONAL PROJECTS 2016/2017



IRAN

**SEMINARS IN TABRIZ AND TEHERAN - COMING SOON**



CANADA/USA

**PROMOTIONAL PROGRAM 2016  
FOR NORTH AMERICA - TO BE DEFINED**





quaderni di assorestauro



YEAR05NR01