ADVANCED TRAINING ON ENERGY EFFICIENCY IN HISTORIC HERITAGE

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COLLECTION OF CASE STUDIES

EHCMAP
Advanced Training on Energy Efficiency in Historic Buildings

Co-funded by the Erasmus+ Programme of the European Union

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UNIVERSIDADE DO ALGARVE
CRIA – DIVISÃO DE EMPREENDEDORISMO E TRANSFERÊNCIA DE TECNOLOGIA

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Collection of case studies

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CASE STUDIES DATA SHEET

BRAZIL GENERAL CONSULATE

0 KEY WORDS

Thermal inertia

Natural ventilation

Roof Insulation

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1 Type Of Interventions

a. General Information

i. Location

Consulado-geral do Brasil

Praça Dom Marcelino Franco

8000-169 Faro Portugal

GPS: 37° 01'51.96" N / 7°55'59.25" W

Located in the downtown of Faro

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Figure 1_ Territorial framework

Figure 2_ Aerial view of the area where is the Brazil General Consulate.

i. Regulation Constrains

A. Legal Framework of Urban Renewal in Urban Renewed Area

The Legal Framework of Urban Renewal in Urban Renewed Area, Decree-Law No. 307/2009 of 23 October, “Structure rehabilitation interventions based on two fundamental concepts: the concept of "urban renewal area" where the boundary of the municipality has the

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effect of determining the territorial portion that justifies an integrated intervention under this decree-law, and the concept of "urban renewal operation", corresponding to the structure of the interventions to be carried out within their area of urban regeneration".

The third area of Urban Rehabilitation of Faro, located in the neighborhood of the Historical Section of the Moorish quarter, and respective strategy, were approved in the Municipal Assembly of April 29, 2013, and published in Diário da República (National Official Journal), 2nd Series, September 13, 2013.

This building is located in the Urban Renewed Area – Moorish Quarter as plant (Figure 3).


Figure 3_ Urban Rehabilitation Area – Moorish Quarter

B. Classified Building

The typology of the building dates back to the second half of 18th century, with an expansion in the early twentieth century, which accrued the following specific conditions:

a) Is included in the category of Historical Urban Spaces of PDM (Municipal Directory Plan), which " (...) relate to areas of the county, especially important from a historical point of view, cultural and environmental, integrating buildings or built sets of special urban and architectural interest, so that the characteristics of the urban mesh should be kept and the architectural features of buildings of greatest interest should be preserved (...)" – nb. 2 of article 53º of the PDM Regulation.

b) Is identified in the synthesis plant of the Municipal Building Regulation and Urbanization of Faro as Remarkable Building (Figure 4 and 5), category for which they are specific conditions to be observed preferably according to the following works or interventions (Article 60):

Conservation works:

i) Performed for the faithful maintenance of the building's characteristics, with regard to its structural, architectural or decorative elements, and using techniques and materials equal, identical or compatible with the existing ones at the time of its construction;

ii) Admitted total replacements, only in cases in which there is irretrievable breakdown of the elements mentioned in the previous point, duly proved after technical visit carried out by the City Council and under the following conditions:

i) Coating - made for the reconstruction of the pre-existing situation, both as regards the structure or the coating. It is preferable to reuse some materials like timber structure and ceramic tiles flooring, whenever they present conditions to do so;

ii) Facade in lime plaster - made preferably through the use of mortar based on lime and sand, assuming alternatively, the use of bastard mortars, with smooth finish and paint the white lime or pigment or not textured ink, of silicates.

iii) Coating of facades in tile, ceramics or "fake rock" - made through restoration techniques and reproduction of the pre-existing solution, using identical materials or compatible with those techniques.

iv) Masonry - made through the use of identical stones in nature and dimension, to the pre-existing, not being in any case, may be replaced by stones applied as a coating;

v) Carpentry and metalwork - situation where they can be admitted designs and different materials of the pre-existing, if previously approved by the City Council.

Occasionally, in exceptional regime and since examined individually may be admitted solutions making use of non-traditional construction materials and processes, determined specifically for the rehabilitation of this building, if previously approved by the City Council, with the assent of the competent cultural heritage administration.

Change works:

i) Inside buildings or their fractions, provided they do not involve changes in its structure and coverage;

ii) In façades, provided they are designed to:

.Correct tampering caused by relatively recent intervention and/or of notorious poor quality;

.Create openings required for rehabilitation of the building. That being the case visibly contemporary solutions are accepted on condition that, by its design and sobriety, they value the facade and simultaneously mark the time of intervention.

Expansion works:

In depth, through a case by case evaluation, in accordance with legal and regulatory provisions and, if it is proven its indispensability to improve the living conditions of the building.

Demolition works:

i) Partial - if they are interventions that have contributed to the distortion of the building, if do not present safety and health conditions, or if they hinder the rehabilitation of the building;

ii) Total - when the state of conservation of this building offer danger to the conditions of safety and health, being duly attested by municipal inspection required for the purpose.

In the cases provided in the preceding paragraph, can the competent administration of cultural heritage require the completion of reconstruction works with preservation of the facades, performed for the faithful reproduction of the building's features (including the structural, architectural or decorative elements in particular coatings for roofs and walls, mass work, masonry, carpentry, metalwork) and using techniques, materials and colors, equal or compatible with the existing at the time of its construction, or even other, previously removed and reused.

For the purpose of the previous point the administration of the relevant cultural heritage can also determine the elements that should be disassembled and packaged, for the reconstruction of the building.

Figure 4_ Classified Properties in the Mouraria Quartier

Figure 5_ Remarkable Building

i. Protection/Conservation status/level

The rehabilitation design was done in 2011 and in compatibility with the guidelines provided by national laws.
Nowadays the building is in very good conditions and in operation as the Brazil General Consulate for the Algarve.

b. General Description _ Before reabilitation/Restoration

i. Date of construction

Second half of the eighteenth century, with an expansion in the early 20th century.

ii. Architect

Unknown

Figure 6_ Brazil General Consulate

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iii. Architectural style/styles

Civil Architecture

iv. Construction phases

- Phase 1: Second half of XVIII century - private noble house
- Phase 2: 1937 - Expansion to adjoining building
- Phase 3: 2011- Reabilitation works without a defined use
- Phase 4: 2013 - Brazil General Consulate

i. Original use

Private house

Figure 7_ Picture of the building in 2007 (Google earth, Street view)

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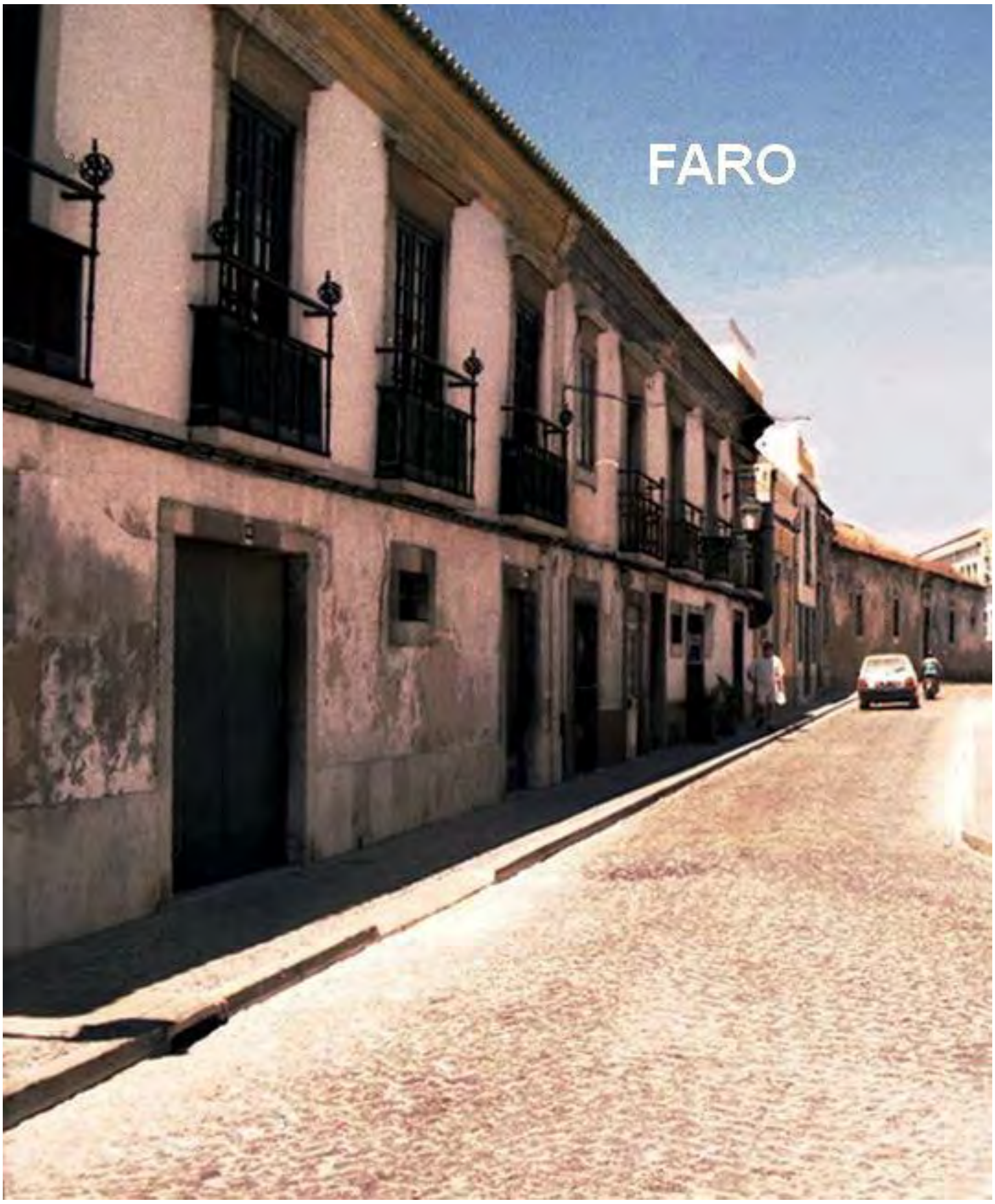

Figure 8_ Picture of the building at the 80s.

In the years prior to its recovery in 2007, the building had a continuing degradation as a result of not being in use. In 2007 underwent some maintenance work, but essentially covers and exterior plasters. In 2011 underwent a deeper intervention, for adaptation to non-residential use, not discriminated. The state of the building before rehabilitation is shown in Figures 9 and 10.

Figure 9_ Picture of the building before rehabilitation

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Figure 10_ Pictures of the building (inside) before rehabilitation

ii. Construction materials

• Walls - stone blocks

• Floors and roofs – concrete slabs and wood structure on the roofs

iii. Construction method

- Wall systems:

Exterior walls, 80 cm thick, and some interior walls in stone masonry, as plant.

- Floors and roofs systems:

The floors are made of slabs of reinforced concrete, which remained unchanged.

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The covers are made of wood beams which in most cases are visible at the bottom and at the top, receiving a mat and framework for supporting tiles.

Figure 11_ Rehabilitation of the wood structure of de roofs

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c. GENERAL DESCRIPTION _AFTER RESTORATION

i. **Date of rehabilitation/restoration**

2011

ii. **Architect**

Gonçalo Rita Brito Vargas

iii. **Typology of building**

This is a property characterized by integrating a courtyard garden, bordering two of the streets. The building itself is a trapezoidal building with two floors and a high tower, pitched roofs and a small terrace with accessibility.

iv. **Current use**

Brazil General Consulate

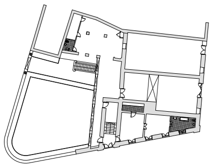

Figure 3_ Ground floor before the rehabilitation

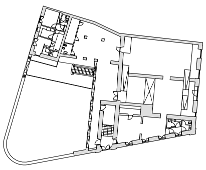

Figure 4_ Ground floor after the rehabilitation

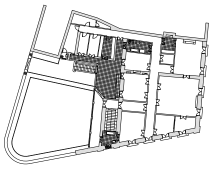

Figure 14_ First floor before the rehabilitation

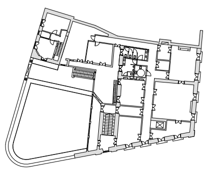

Figure 15_ First floor after the rehabilitation

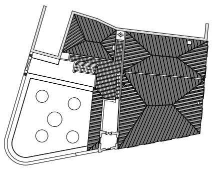

Figure 16_Tower floor

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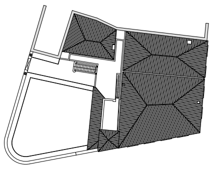

Figure 17_Roofs

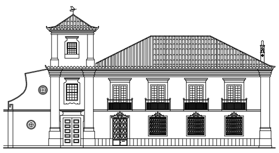

Figure 18_ East elevation

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Figure 19_ Section

Figure 20_ North elevation before the rehabilitation

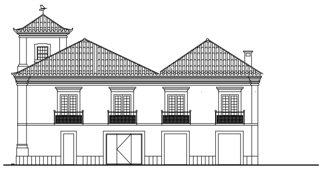

Figure 21_ North elevation after the rehabilitation

v. Construction materials and construction methods

- Walls

The walls were picked by removing the plaster of about 3 cm thick, which had been deteriorated due to moisture / rainfall that directly affected the walls or timber elements rested on the walls (roof trusses). By the action of moisture the wood swelled, causing detachment on the walls (Figure 22).

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Figure 22_Walls without plasters

- Roofs

The roofs were all intervened because they were in an advanced state of degradation. Some were demolished and others were rebuilt, always with the same dimensions and architectural features. The material used was essentially wood and when needed metal reinforcements were made (Figure 23).

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Figure 23_ Intervention in roofs

- Reinforced concrete elements

In the 1937 intervention were used elements of reinforced concrete. The coatings of armor were clearly insufficient. The process of time and the presence of moisture caused an increase of the section of rods due to corrosion, so the pieces were cracked and in some points, the armor was discovered.

In some exterior elements, where the steel had a high level of corrosion, this was brushed and reinforced, and then painted with SIKA-Ferroguard, ending with the application of mortar monolayer SIKA-Monotop. (Figure 24).

Figura 24_ Degraded concrete slabs

vi. Short description of building

It is a building of two floors plus a tower and a garden patio, with features of "Ground" period, with longitudinal plant and treasure roofs. The two relevant facades have windows and balcony with railings iron, and cover with impressive overhangs.
(Figure 25).

Figure 25_ Refurbished building

vii. **Overall conservation status**

As a result of a careful rehabilitation and because it is occupied by a single entity with economic capacity to promote its regular maintenance, the building is in excellent condition of preservation. The rehabilitation of this building also provided it with thermal and acoustic insulation making it comfortable for its occupants and allowing energy savings.

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viii. Current European Energy Standard

European legislation on energy efficiency in historic buildings does not require compliance with minimum standards and grants the power of decision to the member countries. Thus, the legislation to any intervention on the heritage varies between EU member states.

In Portugal the national regulations exclude monuments and buildings individually classified or to be classified, those that are recognized special architectural and historical value and buildings integrated in sets or classified sites or to be classified, or located within protection zones (DL 118/2013).

d. URBAN CONTEXT

i. General description

The Ria Formosa lagoon attracted human occupants from the Palaeolithic age until the end of pre-history. From the 4th century b.c a settlement grew up – Ossonoba – which was an important town during the period of Roman occupation and, according to historians, the forerunner of present-day Faro. From the 3rd century onwards and during the Visigothic period this was the site of an Episcopal see. With the advent of Moorish rule in the 8th century Ossonoba retained its status as the most important town in the southwest corner of the Iberian Peninsula. In the 9th century it became the capital of a short-lived princedom and was fortified with a ring of defensive walls. The the name Santa Maria ("Shantamariyyat al-Gharb" in Arabic) began to be used instead of

Ossonoba in the 10th century. Later on the town was known as Santa Maria de Faaron and finally Faro. The Moors were defeated by the forces of the Portuguese King Afonso III, in 1249. With the Christian conquest the city grew and it settled an important Jewish community that, in 1487, is responsible for the first book printed in Portugal. With the decline of the importance of the city of Silves, Faro took over the role of administration of the Algarve area.

ii. Analytic description

History of its formation

Faro always enjoyed a strategic location related to the proximity of the Ria Formosa lagoon and, therefore, due to the commercial port. Like other towns on the coast of the Algarve, Faro developed initially a specially oriented vocation for trade, with the sea as main relationship vehicle with other peoples and cultures.

During the Roman occupation (from the end of the third century BC) its importance as a point of commercial and cultural exchanges, allowed an organized urban development along the banks of the port, highlighting the currently walled structure as the main civic center, where was located the Forum. Its urban structure was based on two perpendicular axes, the cardus and the decumanus, axes which still constitute the matrix of its urban shape, matrix in which were organized the main administrative and religious buildings in the city. (Figure_26).

Figure 5_ Faro – Urban Structure

During the Arab rule was reinforced the walled waist of the high area. At that time occurred several changes, including the construction of new access doors, such as the oldest Arabic entry that still exists today, and the construction of albarrã towers, that would communicate with an inner ring, which today is still visible in the actual urban matrix structure. Inside the walled structure would be located also the mosque and the citadel, the latter located in the space of the former Castle and the old beer factory. (Figure_27).

Figure 27_ Walled structure

From the Christian reconquest to the consolidation of its urban form

During the medieval period the intramural occupation is densified and it should be noted the presence of the Jewish quarter, located in the area of the former convent of Our Lady of the Assumption, now the Municipal Museum. The political and religious functions remain once again linked to the walled area, finding in it the Castle, the Cathedral and the Town Hall.

The expansion and consolidation of extramural area focused mainly on the market area and Mouraria as well as in river bank, strengthening its natural vocation, more related to the sea.

Thus, the extent of urban structure is made from the emergence of religious buildings, chapels, along the principal axes of access to the city.

From the densification of these routes and the creation of new enlargement spaces, such as parks or squares, the city takes shape, and turns in what is its current urban shape. From the sixteenth century, the emergence of the Religious Orders that will be installed on the outskirts of the urban agglomeration, with some monastic structures, will help to define what, for a long time, represented the consolidated city (Figure 28).

Figure 28_ Consolidated city

From the construction of the wall to the creation of a new rail limit

In the seventeenth century, and following the defense policy implemented by the kingdom, fences were built in various cities, and Faro was no exception (Figure 27).

Covering a wide area of the city and surrounding areas, in order to include the vast majority of religious structures located on the outskirts of the cluster, the Seventeenth Fence of Faro has provided the city a second largest urban outline that prevailed intact until the late nineteenth century.

With the construction of the railway, in the late nineteenth century (1889), Faro met a new limit, giving rise to new coastal structures - the station neighborhood and the current marina. The new limit or barrier conditioned the transformation and expansion of the city and its relationship with the Ria Formosa lagoon.

Figure 29_ Faro, the late nineteenth century

The twentieth century

In the beginning of the twentieth century, the city breaks with the established limits - the Seventeenth Century Fence - and sets new limits:

• the first ring road (1883), in the North and East;

• the railway (1889), in the South and West, have led to new coastal structures - the station neighborhood and the current marina.

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Contained in these new limits, the city will grow over the basic axes in direction to North and East, resulting in the emergence of new "crowns" at an early stage, through the so-called "urbanization of kitchen gardens", ie the occupation for urban purposes of old plots belonging to the fences of the monasteries - St. Francis and the College - 1927 and later São Pedro and Capuchos.

From the second half of the twentieth the city framed in the new urban policy enacted by Duarte Pacheco, will be developed in accordance with the new municipal guidelines. We refer specifically to Faro Urbanization General Plan (PGU 1945) that having as main objectives: locate public buildings and social facilities and the planning of the urban transit, will propose a redesign of the city. This is based on a new system of axes resulting from the redefinition of the existing, and simultaneously, the opening of new ones.

Figure 30_ Faro, PGU 1945

Justified either by financial inability of municipalities by inaction or delays in the approval by the central government, by inadequate law of soil or even because of the economic growth of that period which have favoured the private sector to the detriment of the public, the rate of implementation of the actions that were part of the PGU 1945 was reduced. The revision of the PGU in 1963 revealed that the major equipment and public services and infrastructure networks were built, and were initiated some expansion cores. In the case of residential buildings, the city was being occupied over the new axes, mostly by buildings of one and two levels (isolated), and two and three floors (band). Nevertheless the urban fabric was not strongly affected by some axes proposed in the PGU version of 1945. In summary, the PGU worked primarily as a guiding tool of urban management.

The new realities that have occurred in the Algarve region from the end of the 60s - with the appearance of the Sun & Sea tourism - and in the 70s, - with the implementation of the democratic regime - will result in the growth of the city along the routes of entry and in the deepening of the pre-existing urban fabric, which resulted in the coexistence and diversity of various functions. In this context

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arises, since the beginning of the 80s, a new limit - the "second ring road", the Calouste Gulbenkian Avenue, and is elaborated a new general plan of urbanization (1980).

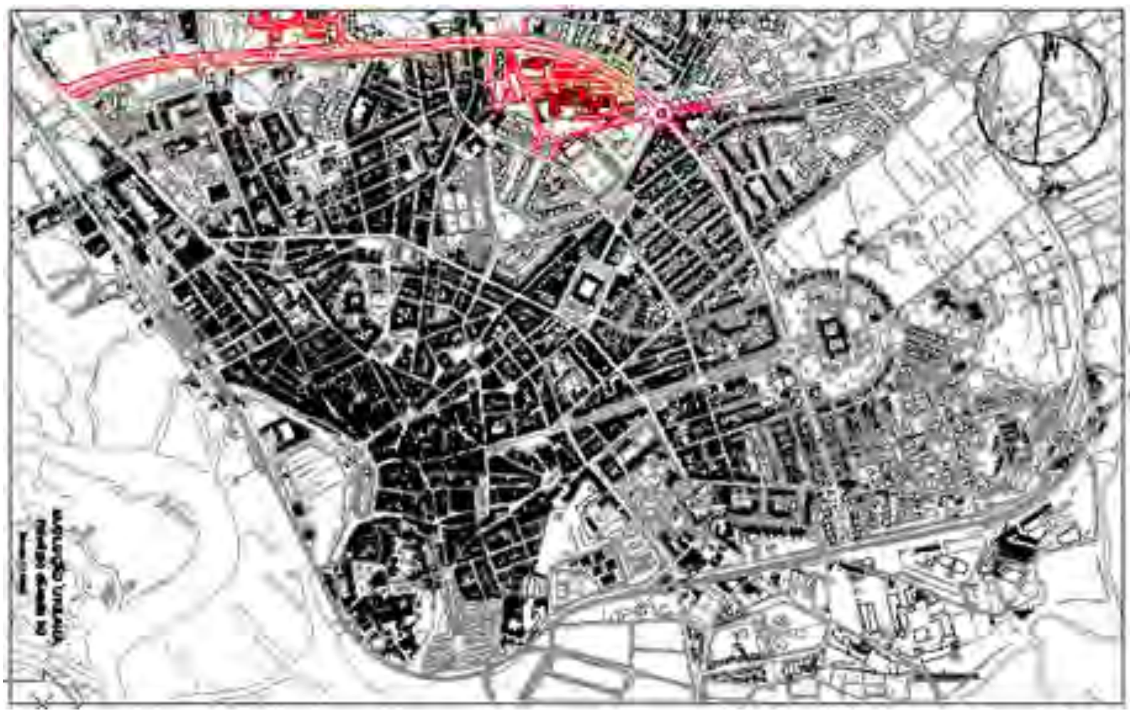

Figure 31_ The "second ring road", the Calouste Gulbenkian Avenue

Figure 32_ Faro, twentieth century

e. Local Climate Data

i. General description

Mediterranean climate

Climatic Zone I1 V2

ii. Analytic description

- 1060 degree days (base 20ºC)
- 4.3 months duration of the hot season
- External temperature of the project - Summer 32 ° C
- 12º C Temperature range

f. Energy Demand

i. Building Energy performance

The conditions of thermal comfort for the building are listed in Regulation of Energy, HVAC systems in buildings (DL 118/98):

- Summer: 25 ° C, 50% RH
- Winter: 20 ° C, 50% RH

Given the need for energy savings, these values should be regarded as minimum guidelines for summer and upper limits for the winter.

ii. Passive measures

- Good insulation and caulking coverage in order to minimize heat gain in summer and winter losses.
- Strong thermal inertia for which there is the significant contribution of the exterior walls with 80 cm thick and some interiors, of stone masonry, which is critical to the performance of the building in the summer.
- Natural ventilation achieved by the presence of openings in opposite facades. In the summer on very hot days, the use of natural ventilation at night helps to cool the rooms.
- Interior wood shutters in all the glazing, which allow to control the heat gain in summer.

iii. Climate environment (HVAC)

The main compartments (rooms and halls) have air conditioning units to heat in winter and cooling in summer.

iv. **Lighting**

All lamps are the economic type and is expected to be replaced by LEDs.

The lighting in all common areas is controlled by motion sensors.

2 GENERAL OBJECTIVES

a) To preserve the building;
b) Minimum possible changes, maximizing the use of space for the new functions;
c) Sustainable intervention, both in terms of construction and in terms of operation and maintenance in the short / medium term;
d) Saving resources, particularly energy for lighting, air conditioning and heating WC water;
e) Thermal and acoustical comfort in the rooms;
f) Integration between new technological improvements and the existing building.

3 REFERENCES

a. “Faro, Evolução Urbana e Patruimónio” (1993), Paula, M.
b. “Proposal of the historic district of Faro Urban Plan "(2001) Characterization - Chapter Urban Evolution of the City. Division of Historical Center. Faro City Council.
c. http://en.wikipedia.org/wiki/Faro,_Portugal

4 ACKNOWLDGE

We acknowledge the engineers and architects who were responsible for the building rehabilitation project, in particular Eng. António André, from company Protecna Lda., for having provided relevant technical information and photographic archive.

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CASE STUDIES DATA SHEET

1878 HOSTEL FARO

0 KEY WORDS

Thermal inertia
Natural ventilation
Roof Insulation
Solar panels

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1 Type Of Interventions

a. General Information

i. Location

1878 Hostel

Rua Serpa Pinto n.º29

8000-431 Faro Portugal

GPS: 37° 01'06.62" N / 7°55'45.38" W

Located in the downtown of Faro

Figure 1_ Territorial framework

Figure 2_ Aerial view of the area where is 1878 Hostel.

i. Regulation Constrains

A. Legal Framework of Urban Renewal in Urban Renewed Area

The Legal Framework of Urban Renewal in Urban Renewed Area, Decree-Law No. 307/2009 of 23 October, “Structure rehabilitation interventions based on two fundamental concepts: the concept of "urban renewal area" where the boundary of the municipality has the effect of determining the territorial portion that justifies an integrated intervention under this decree-law, and the concept of "urban renewal operation ', corresponding to the structure of the interventions to be carried out within their area of urban regeneration".

This building is located in the Urban Area Renewed - Riverside Neighborhood, as plant (Figure 3).

Figure 3- Area of Urban Rehabilitation - Neighborhood Riverside Faro

B. Classified Building

The typology of the building dates back to the late nineteenth century (1878) and presents the following specific conditions:

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a) integrates the category of the Historical Urban Spaces of PDM (Directory Municipality Plan) which "(...) usually are especially important areas of the city, from the historical, cultural and environmental point of view, integrating buildings (or groups of buildings), of special urban and architectural interest, so the urban characteristics of the meshes should be maintained and the architectural features of buildings of greater interest should be preserved (...) "- article 53 paragraph 2 of the PDM Regulation.
b) It is identified in the synthesis plant, of the Faro Municipal Building Regulations and Urbanization, as Building Outstanding (Figure 4 and 5), the category for which are specific conditions to be observed preferably according to the following works or interventions (Article 60):

   Conservation works:

   i) Executed for the faithful maintenance of the building's characteristics, with regard to its structural elements, architectural or decorative, using equal techniques and materials, compatible with the existing ones at the time of its construction;

   ii) Admitted total replacements, only in cases where there is the irretrievable breakdown of the elements mentioned in the previous point, duly established after technical visit made by the City Council and under the following conditions:

i) Coating - made for the reconstruction of the pre-existing situation, both as regards the structure or the coating. It is preferable to reuse some materials like timber structure and ceramic tiles flooring, whenever they present conditions to do so;

ii) Façade in lime plaster - made preferably through the use of mortar based on lime and sand, assuming alternatively, the use of bastard mortars, with smooth finish and paint the white lime or pigment or not textured ink, of silicates.

iii) Coating of façades in tile, ceramics or "fake rock" - made through restoration techniques and reproduction of pre-existing solution, using identical materials or compatible with those techniques.

iv) Masonry - made through the use of identical stones in nature and dimension, to pre-existing, not being in any case, may be replaced by stones applied as a coating;

v) Carpentry and metalwork - situation where they can be admitted designs and different materials of pre-existing, if previously approved by the City Council.

Occasionally, in exceptional regime and since examined individually, may be admitted construction materials and processes, non-traditional, determined by solution for the rehabilitation of the building, if previously approved by the City Council, with the assent of the cultural heritage management public authority.

Change works:

i) Inside buildings or their fractions, since it does not involve changes in the structure and coverage;

ii) In façades, provided they are designed to: correct tampering caused by relatively recent intervention and/or notorious poor quality; create openings required for rehabilitation of the building. In the latter case contemporary solutions are allowed provided that due to its design and sobriety value the façade and simultaneously mark the time of intervention.

Extension work:

In depth, through a case by case evaluation, in accordance with legal and regulatory provisions and, if it is proven its indispensability to improve the living conditions of the building.

Demolition works:

i) Partial - when interventions contributed to the distortion of the building, do not present safety and health conditions or impede the rehabilitation of the building;

ii) Total - when the state of conservation of this building offer danger to the conditions of safety and health, being this situation duly attested by municipal inspection required for the purpose.

In the cases provided in the preceding paragraph, can the competent administration of cultural heritage require the completion of reconstruction works with preservation of the facades, performed for the faithful reproduction of the building's features (including the structural, architectural or decorative elements in particular roofing and wall coverings, mass work, masonry, carpentry, metalwork) and, using techniques, the same or compatible materials and colors with the existing at the time of its construction, or even other, previously removed and reused.

For the purpose of the previous point, the competent administration of cultural heritage may also determine the elements that should be disassembled and packed in order to rebuild the building.

Figure 4_ Properties classified in Faro Riverside Neighborhood

Figure 5_ Notable building

i. Protection/Conservation status/level

The rehabilitation design was done in 2013 and in compatibility with the guidelines provided by national laws.

Nowadays the building is in very good conditions and in operation as a hostel since August 2014 (http://1878hostel.com).

b. GENERAL DESCRIPTION _ BEFORE REABILITATION/RESTORATION

i. Date of construction

1878

ii. Architect

Unknown

Figure 6_ Private house

Figure 7_ Regular Primary School

Figure 8_ Institution of Girls Protection (80's decade)

iii. Architectural style/styles

Civil Architecture

iv. Construction phases

- Phase 1: 1878- 1901– private house
- Phase 2: 1902-1918 –Training School for Primary School Teachers
- Phase 2: 1919-1939 - Regular Primary School
- Phase 3: 1940-2002 Institution of Girls Protection
- Phase 5: 2002-2014 not used (Hostel opened on August 2014)

i. Original use

Private house

Figure 9_ Picture of the building in 2007 (Google earth, Street view)

In the last years the building had a very rapid degradation, both outside or inside, mainly due to lack of tightness of the covers and the collapse of the glazing. The owner opted for closing the openings through ceramic brick. The state of the building before rehabilitation is illustrating on the figures 10 and 11.

Figure 10_ Pictures of the building before rehabilitation (October 2013)

Figure 11_ Pictures, inside the building, before rehabilitation (October 2013)

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ii. **Construction materials**

• Walls - stone blocks

• Floors and roofs - wood structure

iii. **Construction method**

- Wall systems:

Outer walls of 70 to 90 cm thick and some interior walls of stone masonry as plant.

- Floors and roofs systems:

The floors are made of wooden framework. At the bottom there is a ceiling conveyor, and at the top, the floor is wooden board.

The covers are made of wood beams which in most cases are visible at the bottom and at the top, receiving a mat and framework for supporting tiles.

c. GENERAL DESCRIPTION _AFTER RESTORATION

i. **Date of rehabilitation/restoration**
2014

ii. **Architect**

Emanuel José Pereira Anacleto

iii. **Typology of building**

Trapezoidal building with 2 floors high. It has sloping roofs and a terrace.

Current use

Hostel

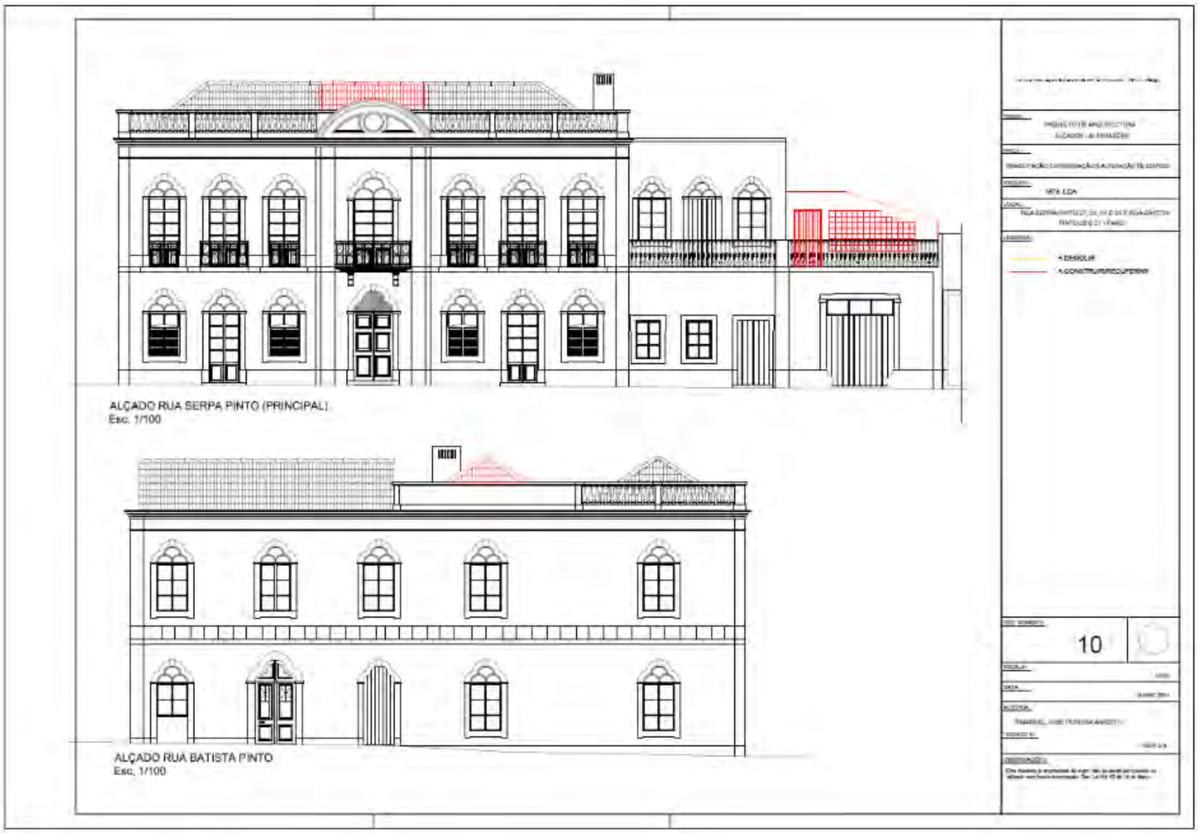

Figure 3_ Façades

Figure 13_ Ground floor

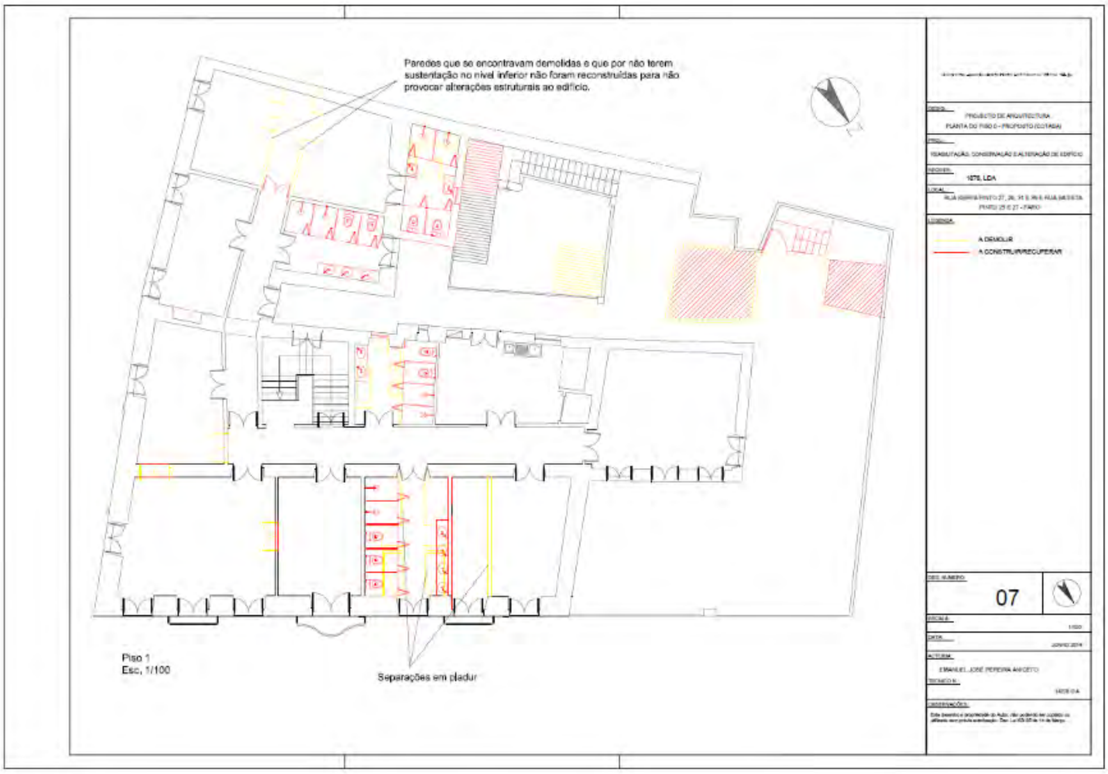

Figure 14_First floor

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Figure 15_ Roofs

Figure 4_ cross section in the main staircase

iv. Construction materials and construction methods

- Walls

The walls were picked by removing the plaster of about 3 cm thick, which were damaged due to the action of moisture, and rain directly affecting the walls or timber elements rested on the walls (roof trusses and floor framework). By the action of moisture the wood swelled, causing detachment on the walls (Figure 17).

For new plaster were selected special mortars, appropriated for the base, which in some cases was limestone walls, mud walls in other cases, in other cases constituted by rods arranged horizontally and others with limestone and lime mortar, complemented by timber according to the Pombal construction method. Thus, in general, SECIL mortars were used - rehabilitates RR or lime mortars, using fiber to reinforce the corners and the base material change zones, to prevent future cracking.

Figure 5_ Walls without plasters.

- Roofs and floors

The roofing was all intervened, being in an advanced state of degradation. Some were demolished, others rebuilt always with the same dimensions and architectural features. The material used was essentially the glued laminated wood and metal reinforcements when necessary (Figure 18).

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Figure 18_ Intervention in roofs

In the pitched roofs the tiles used were those that existed at the top and new ones in the channel (Figure 19).


Figure 19_ tiling

The wooden floors that had noise or were without resistance were replaced by new hardwood flooring, with the same construction method (Figure 20). An acoustic blanket in order to ensure acoustic isolation percussion sounds has now been applied. Where it was not possible to put it, rock wool was used on top of the existing lining.

Figure 20_ Reconstruction of floors

- Reinforced concrete elements

In the first intervention, in 1940, were used elements of reinforced concrete. The coatings of armor were clearly insufficient. The process of time and the presence of moisture caused an increase of the section bars due to corrosion, leading to cracked pieces and in places, the armor to be seen. In some exterior elements, where the steel had a high level of corrosion, this was brushed and reinforced, and then painted with SIKA-Ferroguard, ending with the application of mortar monolayer SIKA-Monotop.

The flagstone terrace was demolished and replaced by a prestressed beams (Figure 21),

Figure 6_New terrace

- Flooring

The lining of the floors have been recovered in some cases using hydraulic mosaics, in other cases, pine wood floor 30 mm thick. There was also the possibility of recovering existing floor, the latter has been treated with application of anti Xylophagous cracks and repair (Figure 22).

Figure 7_Flooring

- Secondary elements: windows, doors and shutters

The windows and interior doors are almost all originals. To this end were treated (Figure 23) and when necessary wooden parts were replaced. The same was done with the interior shutters that were in good condition.

Figure 8_Door repair

• **Thermal insulation**

The roofing was all isolated integrating the following layers (from inside to outside):

• wooden trusses (in sight)

• lining casquina, male female type

• Extruded expanded polystyrene plates 8 cm;

• sub tile Onduline with isolated shots with shot screen;

• new tile to the channel and original old tile to the top of the ranks, applied with clip system.

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Figure 24_ Roof thermal insulation

v. Short description of building

Two-storey building with some Moorish features, such as the top hits with balusters, and an imposing central pediment on top, and in the center of the building.

The existence of monumental pilasters and mortar delimit the various bodies of this building.

The bays have stone lintel of three lobes. On the first floor all the main façade of the gaps have cast iron railings, richly ornamented (Figure 25).

Figure 25_ Refurbished building

vi. Overall conservation status

The building was in a state of degradation and abandonment. Thanks to this intervention today we have a building that in addition to undertaking a hotel function displays a general state of preservation. The rehabilitation of the main structural elements, as was the case of roofs and floors, allows the building has 30 more years of life.

The rehabilitation of this building also provided it with thermal and acoustic insulation making it comfortable for its occupants and allowing energy saving.

vii. Current European Energy Standard

European legislation on energy efficiency in historic buildings does not require compliance with minimum standards and grants the power of decision to the member countries. Thus, the legislation to any intervention on the heritage varies between EU member states.

In Portugal the national regulations exclude monuments and buildings individually classified or to be classified, those that are recognized special architectural and historical value and buildings integrated in sets or classified sites or to be classified, or located within protection zones (DL 118/2013).

d. Urban Context

i. General description

The Ria Formosa lagoon attracted human occupants from the Palaeolithic age until the end of pre-history. From the 4th century b.c a settlement grew up – Ossonoba – which was an important town during the period of Roman occupation and, according to historians, the forerunner of present-day Faro. From the 3rd century onwards and during the Visigothic period this was the site of an Episcopal see. With the advent of Moorish rule in the 8th century Ossonoba retained its status as the most important town in the southwest corner of the Iberian Peninsula. In the 9th century it became the capital of a short-lived princedom and was fortified with a ring of defensive walls. The name Santa Maria ("Shantamariyyat al-Gharb" in Arabic) began to be used instead of

Ossonoba in the 10th century. Later on the town was known as Santa Maria de Faaron and finally Faro. The Moors were defeated by the forces of the Portuguese King Afonso III, in 1249. With the Christian conquest the city grew and it settled an important Jewish community that, in 1487, is responsible for the first book printed in Portugal. With the decline of the importance of the city of Silves, Faro took over the role of administration of the Algarve area.

ii. Analytic description

History of its formation

Faro always enjoyed a strategic location related to the proximity of the Ria Formosa lagoon and, therefore, due to the commercial port. Like other towns on the coast of the Algarve, Faro developed initially a specially oriented vocation for trade, with the sea as main relationship vehicle with other peoples and cultures. During the Roman occupation (from the end of the third century BC) its importance as a point of commercial and cultural exchanges, allowed an organized urban development along the banks of the port, highlighting the currently walled structure as the main civic center, where was located the Forum. Its urban structure was based on two perpendicular axes, the cardus and the decumanus, axes which still constitute the matrix of its urban shape, matrix in which were organized the main administrative and religious buildings in the city. (Figure_19).

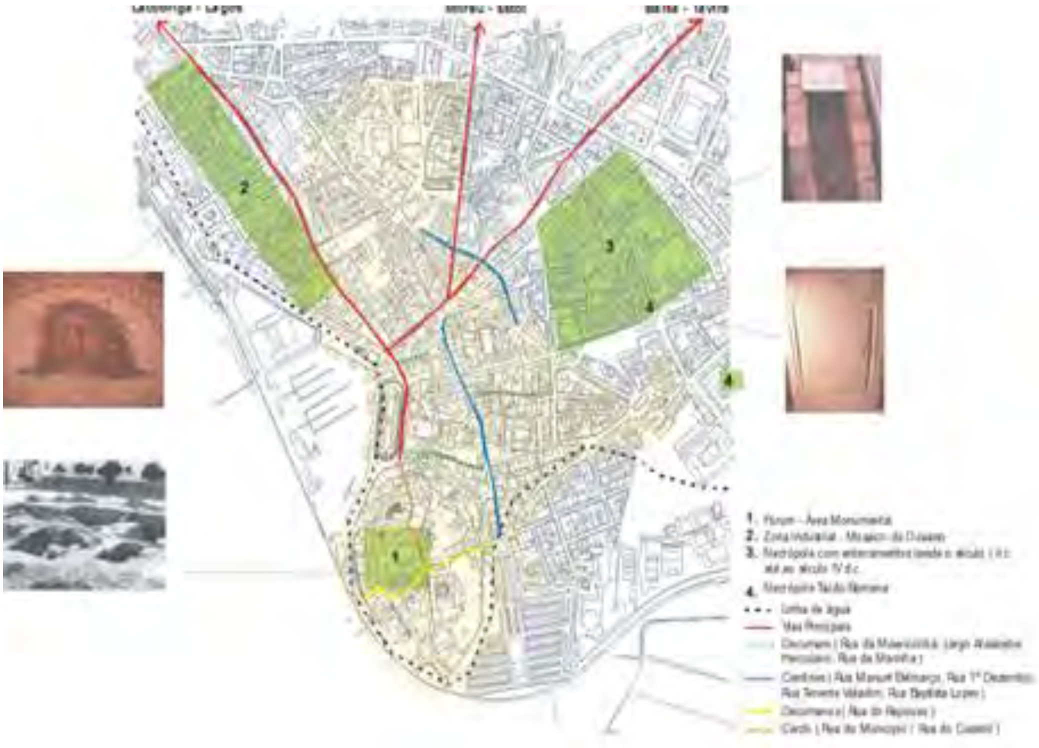

Figure 9_ Faro – Urban Structure

During the Arab rule, within the high core was reinforced the walled waist. At that time took place several changes, including the construction of new access doors, such as the oldest Arabic entry that still exists today, and the construction of albarrã towers, that would communicate with an inner ring, which today is noticeable in the actual urban matrix structure. Inside the walled structure would be located also the mosque and the citadel, the latter located in the space of the former Castle and the old beer factory. (Figure_20).

Figure 27_ Walled structure

From the Christian reconquest to the consolidation of its urban form

During the medieval period the intramural occupation is densified and it should be noted the presence of the Jewish quarter, located in the area of the former convent of Our Lady of the Assumption, now the Municipal Museum. The political and religious functions remain once again linked to the walled area, finding in it the Castle, the Cathedral and the Town Hall.

The expansion and consolidation of extramural area focused mainly on the market area and Mouraria as well as in river bank, strengthening its natural vocation, more related to the sea. Thus, the extent of urban structure is made from the emergence of religious buildings, chapels, along the principal axes of access to the city.

From the densification of these routes and the creation of new enlargement spaces, such as parks or squares, associated with them, the city takes shape, and turning what is your current urban form. From the sixteenth century, the emergence of the Religious Orders that will install on the outskirts of the urban agglomeration, with some monastic structures, will help define what, for a long time, represented the city consolidated (Figure 28).

Figure 28_ Consolidated city

From the construction of the wall to the creation of a new rail limit

In the seventeenth century, and following the defense policy implemented by the kingdom, fences were built in various cities, and Faro was no exception (Figure 22).

Covering a wide area of the city and surrounding areas, in order to include the vast majority of religious structures located on the outskirts of the cluster, the Seventeenth Fence of Faro has provided the city a second largest urban outline that prevailed intact until the late nineteenth century.

With the construction of the railway, in the late nineteenth century (1889), Faro met a new limit, giving rise to new coastal structures - the station neighborhood and the current marina. The new limit or barrier conditioned the transformation and expansion of the city and its relationship with the Ria Formosa lagoon.

Figure 29_ Faro, the late nineteenth century

The twentieth century

In the beginning of the twentieth century, the city breaks with the established limits - the Seventeenth Century Fence - and sets new limits:

- the first ring road (1883), in the North and East;
- the railway (1889), in the South and West, have led to new coastal structures - the station neighborhood and the current marina.

Contained in these new limits, the city will grow over the basic axes in direction to North and East, resulting in the emergence of new "crowns" at an early stage, through the so-called "urbanization of kitchen gardens", ie occupation for urban purposes of old plots belonging to the fences of the monasteries - St. Francis and the College - 1927 and later São Pedro and Capuchos.

From the second half of the twentieth the city framed in the new urban policy enacted by Duarte Pacheco, will be developed in accordance with the new municipal guidelines. We refer specifically to Faro Urbanization General Plan (PGU 1945) that having as main objectives: locate public buildings and social facilities and the planning of the urban transit, will propose a redesign of the city. This is based on a new system of axes resulting from the redefinition of existing, and simultaneously, the opening of new ones.

Figure 30_ Faro, PGU 1945

Justified either by financial inability to issues of municipalities by inaction or delays in the approval by the central government by inadequate law of soil or even because of the economic growth of that period which have favored the private sector to the detriment of the public, the rate of implementation of the actions that were part of the PGU 1945 was reduced. The revision of the PGU in 1963 revealed that the major equipment and public services and infrastructure networks were built, and were initiated some expansion cores. In the case of residential buildings, the city was being occupied over the new axes, mostly by buildings of one and two levels (isolated), and two and three floors (band). Nevertheless the urban fabric was not strongly affected by some axes proposed in the PGU version of 1945. In summary, the PGU worked primarily as a guiding tool of urban management.

The new realities that have occurred in the Algarve region from the end of the 60s - with the appearance of the Sun & Sea tourism - and in the 70s, - with the implementation of the democratic regime - will result in the growth of the city along the routes of entry and in the deepening of the pre-existing urban fabric, which resulted in the coexistence and diversity of various functions. In this context arises, since the beginning of the 80s, a new limit - the "second round", the Calouste Gulbenkian Avenue, and is elaborated a new general plan of urbanization (1980).

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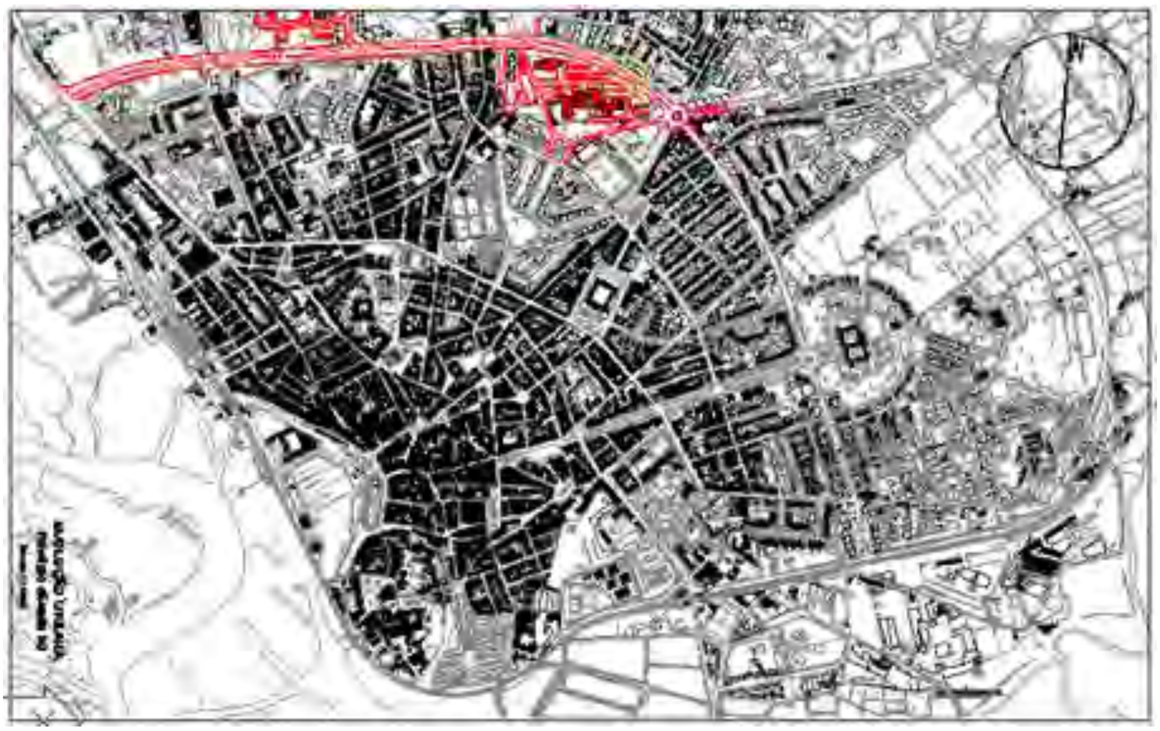

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Figure 31_ Faro, twentieth century

e. LOCAL CLIMATE DATA

i. General description

Mediterranean climate

Climatic Zone I1 V2

ii. Analytic description

- 1060 degree days (base 20ºC)
- 4.3 months duration of the hot season
- External temperature of the project - Summer 32 ° C

  12º C temperature range

f. Energy Demand

i. Building energy performance

The conditions of thermal comfort for the building are listed in Regulation of Energy, HVAC systems in buildings (DL 118/98):

- Summer: 25 ° C, 50% RH
- Winter: 20 ° C, 50% RH

Given the need for energy savings, these values should be regarded as minimum guidelines for summer and upper limits for the winter.

ii. Passive measures

- Good insulation and caulking coverage in order to minimize heat gain in Summer and Winter losses
- Strong thermal inertia for which there is the significant contribution of the exterior walls with 70-90 cm thick and some interiors, of stone masonry, which is critical to the performance of the building in the Summer.
- Natural ventilation achieved by the presence of openings in opposite facades. In the summer on very hot days, natural ventilation at night helps to cool the rooms.

  - Interior wood shutters in all the glazing, which allow to control the heat gain in summer.

ii. Climate environment (HVAC)

The main compartments (rooms and halls) have air conditioning units to heat in winter and cooling in summer. The first run of summer hostel has shown that the building has an optimal thermal performance, not requiring the use of air conditioning to cool.

ii. Solar panels

The heating of hot water is made with solar panels in an area of 16m2, installed on the rooftop (Figure 31) and with the support of two tanks of 1000 liters each. The building has a hot water recirculation system so there is no waste of water. All taps of sinks and showers are timed (30s).

Figure 32_ Solar panels on the roof

iii. Lighting

All lamps are the economic type and is expected to be replaced by LEDs. The lighting in all common areas is controlled by motion sensors.

2 GENERAL OBJECTIVES

a) To preserve the building,
b) Minimum possible changes, maximizing the use of space for the new functions,
c) Sustainable intervention, both in terms of construction and in terms of operation and maintenance in the short / medium term,
d) Saving resources, particularly energy for lighting, air conditioning and heating hot water,
e) Thermal and acoustical comfort in the rooms;
f) Integration between new technological improvements and the existing building.

3 REFERENCES

a. Hostel 1878: http://1878hostel.com/
b. "Proposal of the historic district of Faro Urban Plan "(2001) Characterization - Chapter Urban Evolution of the City. Division of Historical Center. Faro City Council
c. http://en.wikipedia.org/wiki/Faro,_Portugal

4 ACKNOWLDGE

We acknowledge the owners of Hostel 1878, in particular to Eng. Ana Águas, for her kindness and for having provided the relevant technical information and photographic archive.

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EH-CMap
Advanced Training on Energy Efficiency in Historic Heritage

CASE STUDIES DATA SHEET

PORTIMÃO MUSEUM

0 KEY WORDS

Industrial and cultural heritage

Relationship between the city and the river

Natural light

Passive measures

Cooling or pre-cooling by river water

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1 Type Of Interventions

a. General Information

i. Location

Museu de Portimão, Rua D. Carlos I

8500 – 607 Portimão, Portugal

GPS: 37° 7'52.55" N / 8°32'6.84" W

Located on the left bank of the Arade river to 2 km from the mouth

Figure 1_ Territorial framework (Google earth)

Figure 2_ Aerial view of the area where is Portimão Museum (Google earth)

i. Regulation Constraints

A. PDMP – Municipal Plan of Portimão

Resolution of the Council of Ministers No. 53/95 and published in Diário da República, 1st Series-B of 7 June 1995.

Article 1 - ... is to define and establish a spatial structure for the municipality, the classification of soils, urban districts, the urban indices and general rules for the occupation, use and transformation of soil, taking into account the development objectives, the rational distribution of economic activities, housing shortages, equipment, transport and communications networks and infrastructure.

Article 8 - Key elements of the Plan

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Are fundamental elements of PDMP, in addition to this Regulation, the planning plant, which delimits spaces according to their dominant use, and establishes operating units of planning and management, scale 1: 25000, urban perimeters and the plant conditions, which marks the administrative services and utilities restrictions, including those under the National Agricultural Reserve (RAN) and the National Ecological Reserve (REN), areas classified under Decree-Law No. 19/93 of 23 January, the protection areas of classified properties, and areas within public water domain (scale of 1: 25000).

Figure 3_ Municipal Plan of Portimão 1995 (http://planos.cm-Portimão.algarvedigital.pt/#)

Figure 4_ Municipal Plans (http://planos.cm-Portimão.algarvedigital.pt/#)

Figure 5_ Municipal Plans Portimão Museum (http://planos.cm-Portimão.algarvedigital.pt/#)

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B. Valuation Project of Portimão Waterfront

The presence and proximity of the Arade river to the east of the buildings is the main condition for intervention requiring to remake a connection that has already had a much higher relevance. One of the primary objectives of the intervention was to enhance the beauty of the Arade estuary.

The Valuation Project of Portimão Waterfront included the rehabilitation of the front pier and the transformation of the old shipyards in a marina for pleasure boats, which required a careful study of the relationship of these spaces with the Museum and the accompanying equipment.

Figure 6_ Valuation Project of Portimão Waterfront (Decade 90)

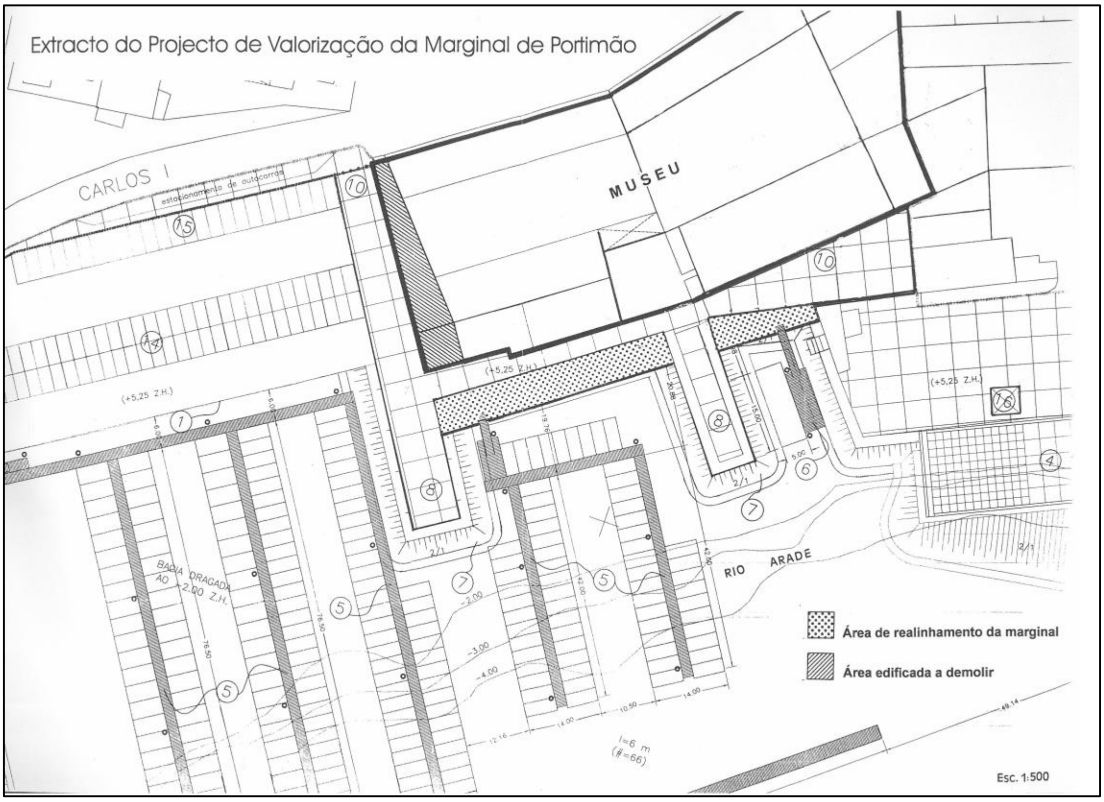

Figure 7_ Valuation Project of Portimão Waterfront (Detail)

B. Museum Program

"Should be understood as a primary working tool, in defining the scope, spaces, functions and services of the future Museum ..... aimed at architectural solution and carry out the building and surrounding area in order to translate and enhance the consistent application of that program and its objectives ";

"New dynamic in the upgrading of industrial structures and urban destination of that waterfront";

"In conjunction with this process of formal and functional rehabilitation of the building, should be taken into account the recent agreements between the Authority and the entities that oversee the Front-Rio to ensure the strengthening of continuity and quality of urban-landscape surrounding of the riverside where the operation will be made, and in which the future museum building is part.

The building is in process of 'classification of municipal interest'. Portimão Museum belongs to the Portuguese Museums Network (RPM), which is an organized structure based on voluntary membership with the aim of promoting decentralization, mediation, accreditation and inter-museum cooperation.

i. Protection/Preservation status

The design was done in compatibility with the guidelines provided by national laws.

Nowadays the building is in very good conditions and in operation (http://www.museudePortimão.pt/en/).

b. General Description _ Before Restoration

i. Date of construction

End of 19th century

ii. Architect

Unknown

Figure 8_ Picture of the complex: “São Francisco” fish and canning factory located on the city’s waterfront (East view) Decade 40

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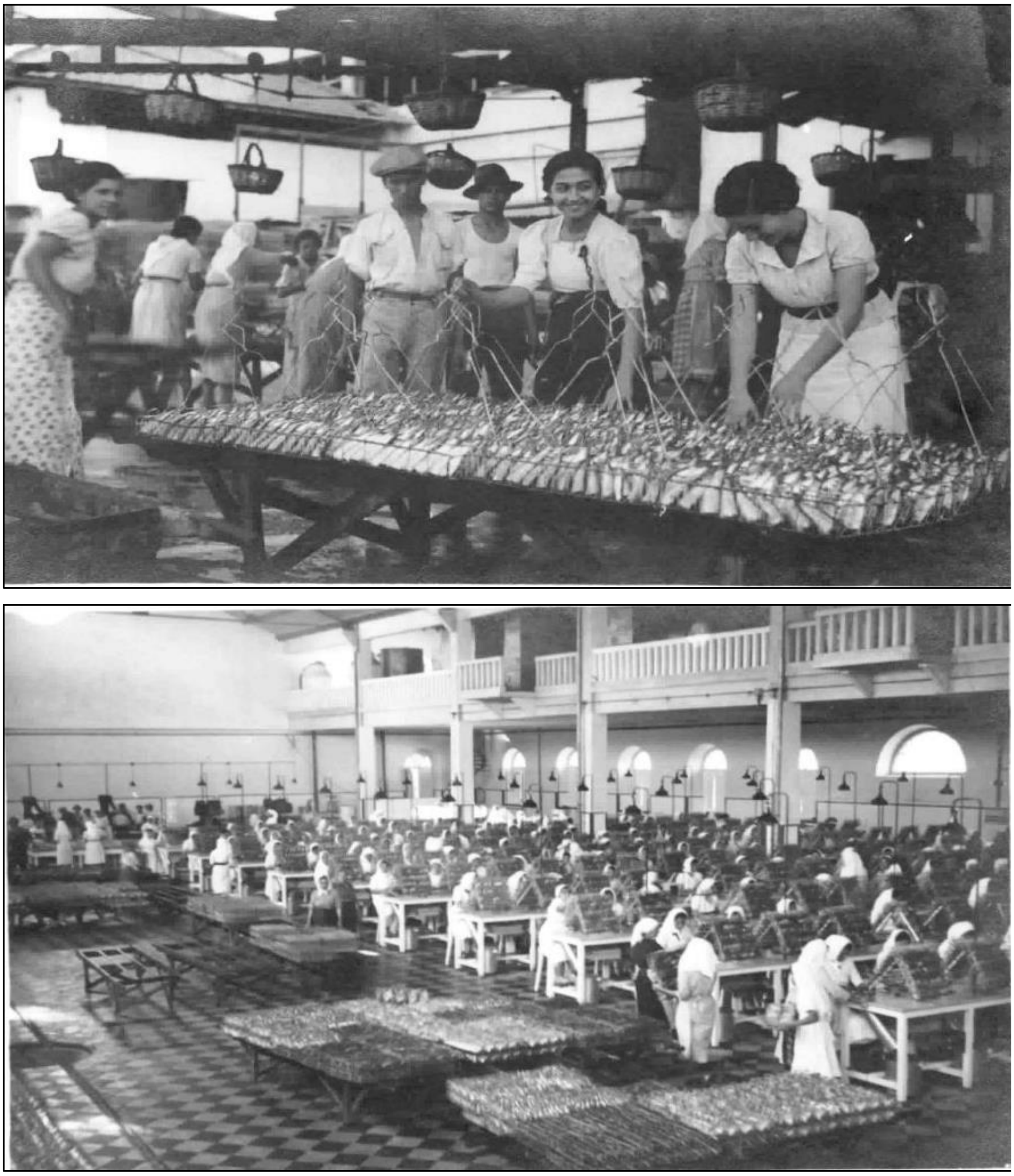

Figure 9_ Workers at “São Francisco” - Decade 40

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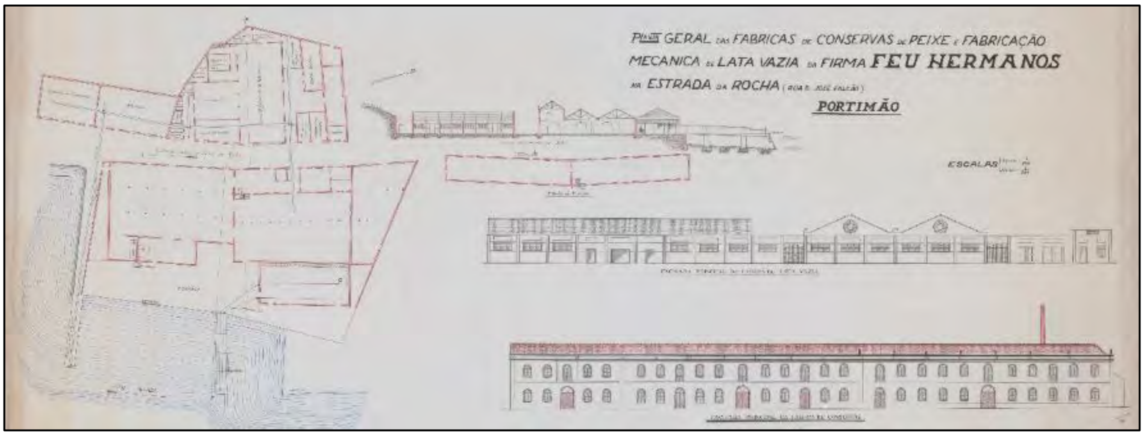

Figure 10_ Plan “São Francisco” fish and canning factory - Decade 50

Figure 11_ Workers at “São Francisco” - Decade 50

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Figure 12_ Aerial view “São Francisco” (East View) - Decade 80

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Figure 13_ Picture of the complex: “São Francisco” (West view) - Decade 80

Figure 14_ Aerial view "São Francisco" (East view) - Decade 90

iii. **Architectural style**

Industrial Architecture

iv. **Construction phases**

Phase 1: main buildings (A1, A2 and A3) dating from the late19th century. Over 20 century the factory had multiple expansions and changes. The factory left to labor in the 80s.

Phase 2: restoration 2005/2007 (opened on 17th May 2008)

v. **Original use**

Fishing and canning factory

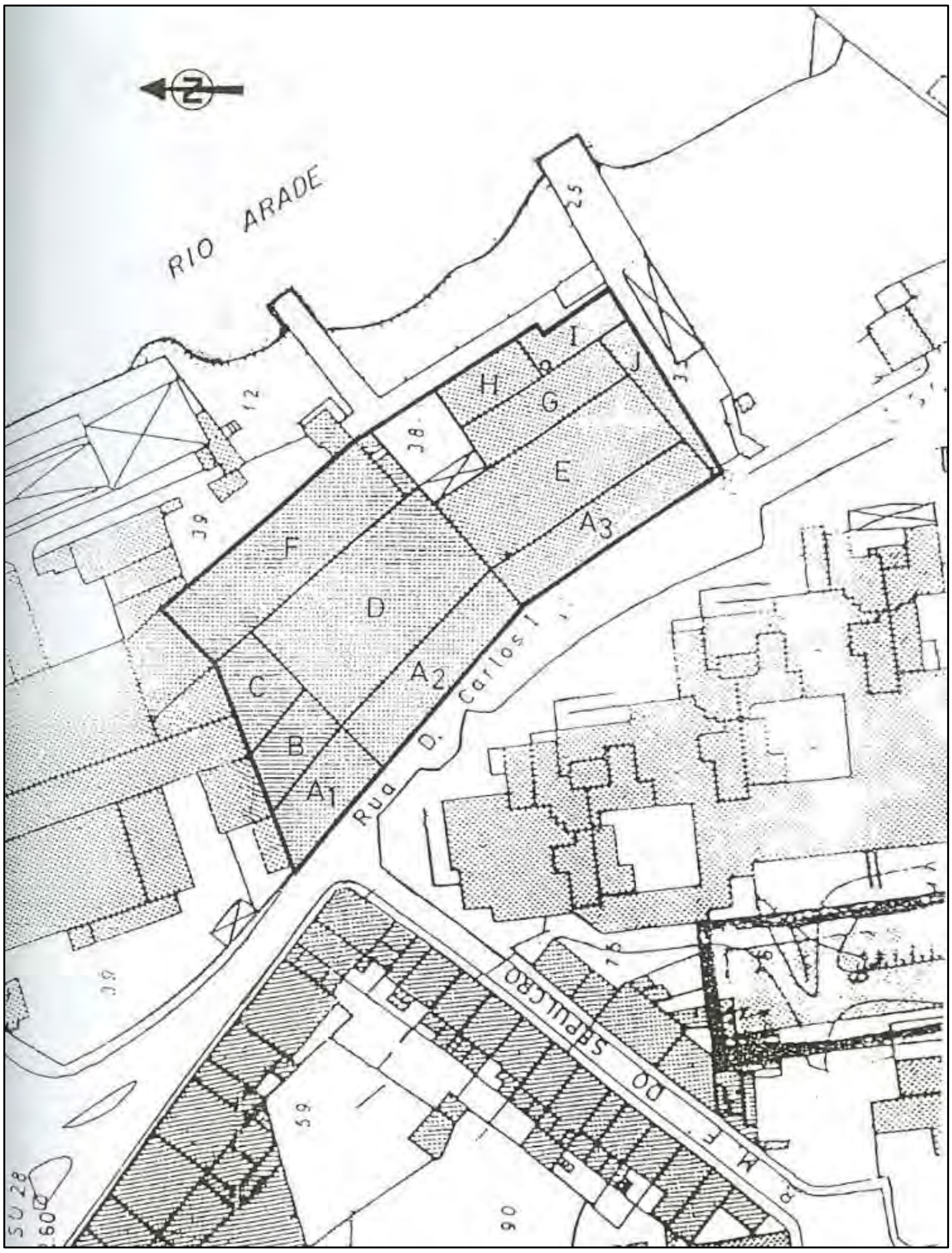

Figure 15_ plant with the location of buildings

vi. Construction materials

- Walls - stone blocks
- Floors and roofs – wood/steel structure

vii. Construction method and preservation

The main industrial buildings (D, E, and G) have rugged masonry walls and the cover structure is constituted by metal trusses and purlins. Despite the buildings were, at the time, in a reasonable state of preservation and security, they were recovered including roof replacement, reinforcement of thermal and acoustic characteristics of the entire enclosure (walls and roofs) and the improvement of conditions, settlements, infiltration, deterioration caused by saltpeter highlights, etc.).

In the washing room (Block F), the solutions were similar except that the roof structure is wood and certain elements needed to be replaced, at the level of support of the truss.

The Building A, skirting the street, had acceptable state of preservation of its main structural and building elements. The walls on the west side are irregular stone masonry with lime based binder. On the eastern side, the walls confronting the buildings (B, D and E) are made of brick-resistant masonry. The cover had to be interventioned, in particular to the roof level and its wooden structure, whose oldest part (A2 and A3) benefited and strengthened in order to receive an interior lining, insulation and ceiling sections of plasterboard.

The foundations of these buildings have been strengthened by micropiles.

The buildings B and C had different preservation conditions, which were described as mediocre, and of problematic recovery. So that it was considered that this area needed further reworded and was built a root volume.

Buildings H and I were in deficient preservation conditions for not having historical or architectural interest (they were relatively recent extensions), so were demolished.

c. General Description _After Restoration

i. Date of restoration

2005/2007

ii. Architect

Isabel Aires e José Cid

iii. Typology of building

Portimão Museum acts as a permanent observatory, and as a venue for cultural mediation, to research, preserv, interpret, publicise and enrich the most important tangible and intangible evidence of the history, heritage, land, memory and identity of the local and regional community, in its interaction with the world.

With one permanent exhibition room (beheading room), two temporary exhibition rooms, a 170-seat auditorium, 3 meeting rooms, a performing arts rehearsal room and the documentation center/historical archive, an area opened to the public with a comprehensive library on subjects close to the museum collection (local and regional history, archaeology, anthropology, etc.) and an archive compiling documentation from the Town Hall and from some fish-canning factories.

iv. Current use

Museum

The success of remodeling and adaptation to new use of an existing building depends to a great extent to accomplish the least possible changes, while maximizing the utilization of structural and logical preexisting spaces.

In this case we were dealing with a factory type building, which would be both receptacle and museum contents agent. So it was important to preserve the most of its architectural structure, including its industrial character, in order to integrate it also in the museum itself as well as the articulation between the various sectors of the new museum.

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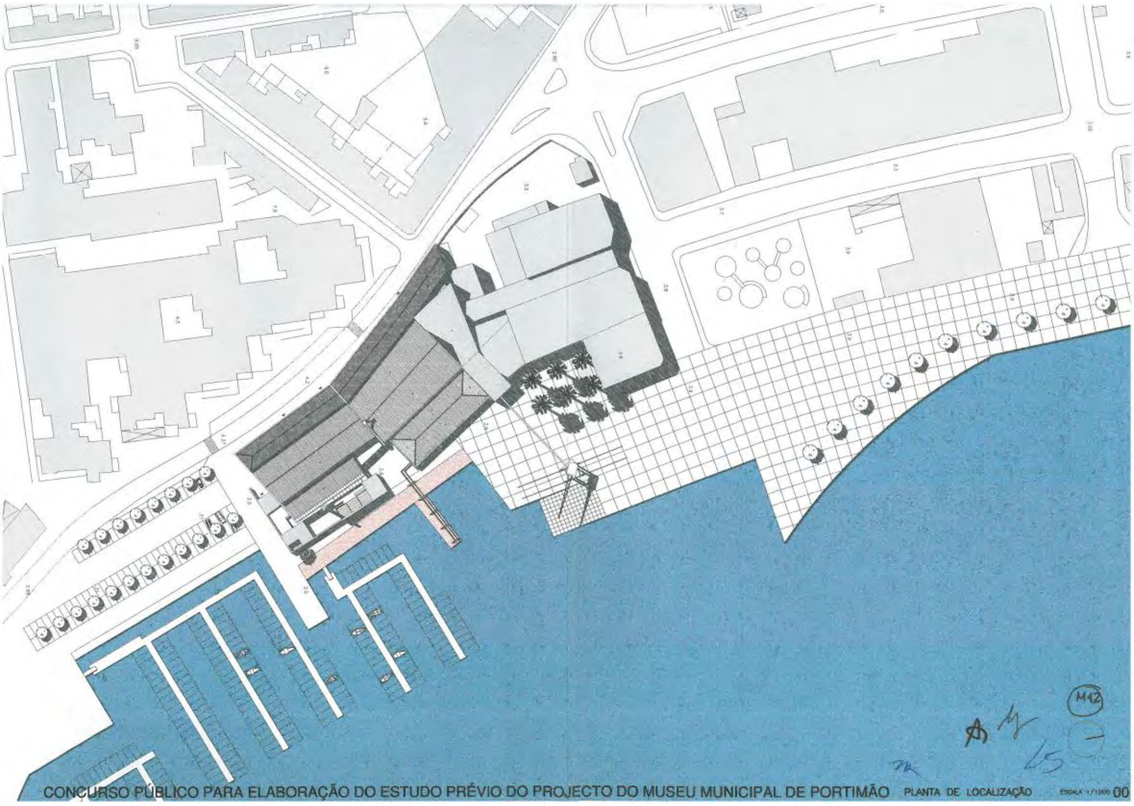

Figure 16_ Portimão Museum (December 1999) Architects Isabel Aires e José Cid – Exterior view

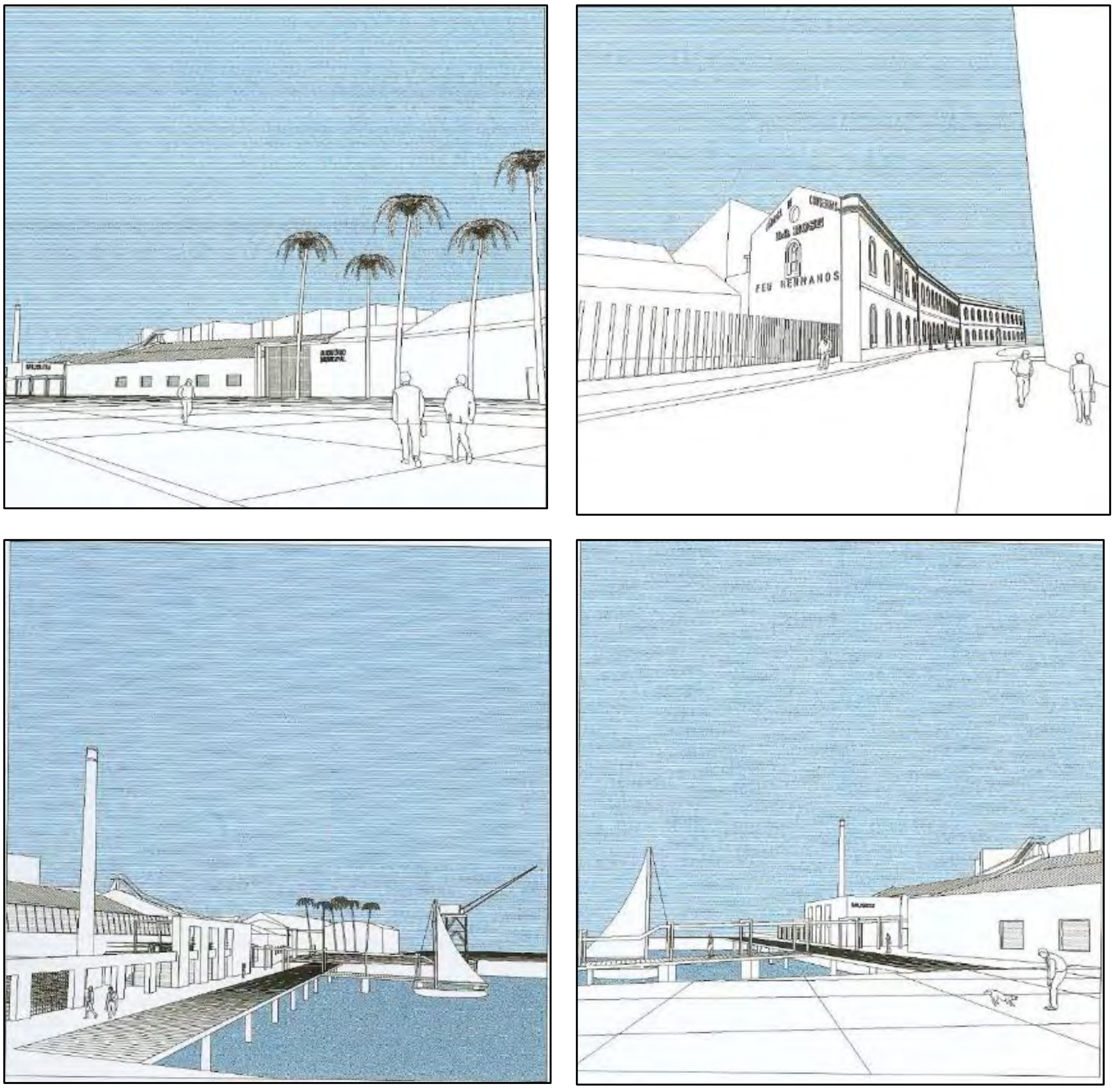

Figure 16_ Portimão Museum (December 1999) Architects Isabel Aires e José Cid – Exterior view

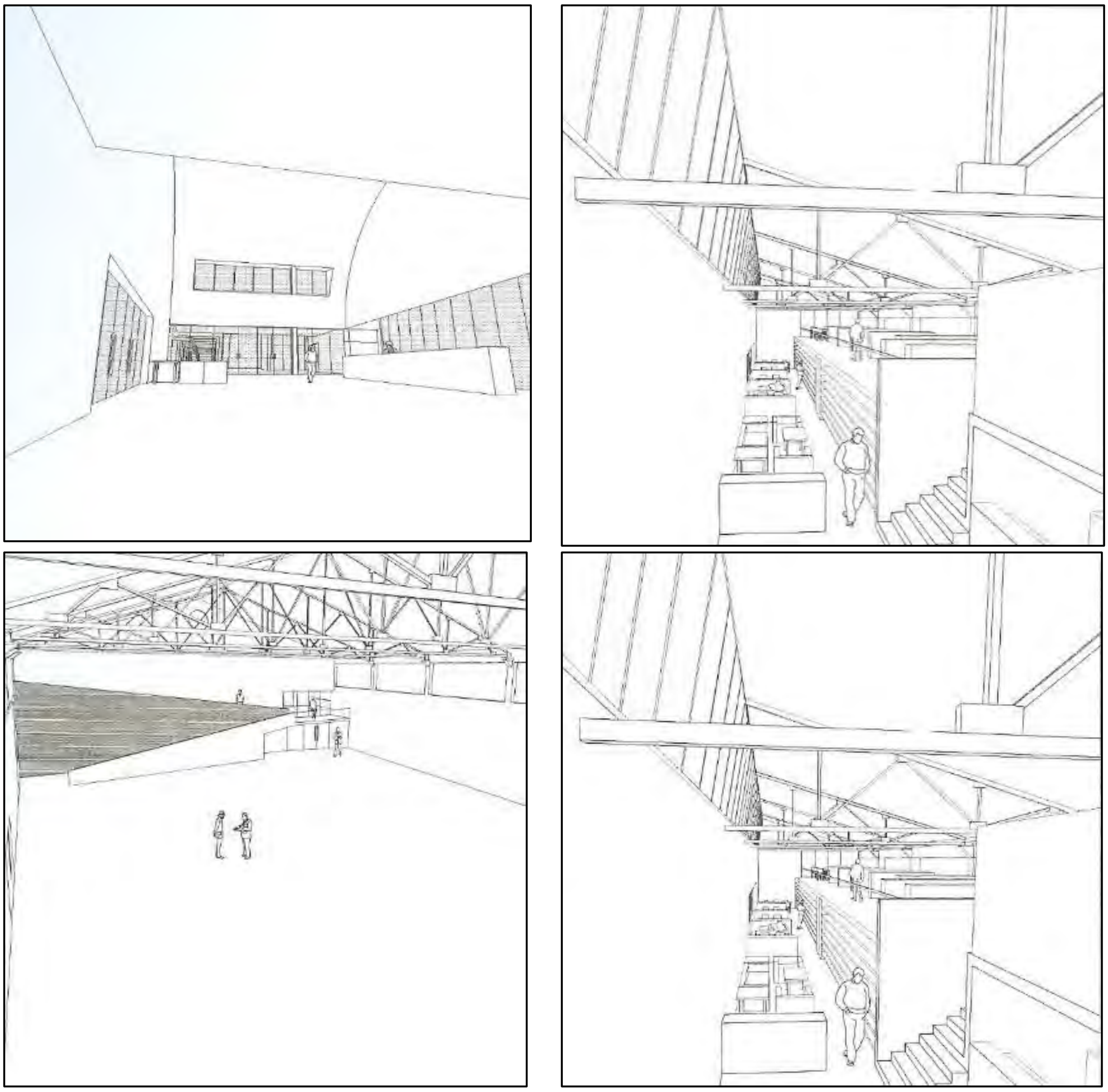

Figure 16_ Portimão Museum (December 1999) Architects Isabel Aires e José Cid – Indoors

v. Construction materials

In the rehabilitation project was given high importance to improving the thermal characteristics and the surrounding acoustic - walls, roofs and openings.

It was necessary to make a structural reinforcement to suit all the buildings to the current anti-seismic regulations. The thickness of most of the outer walls was increased. At that time were also made air boxes, and insulating layers.

O acabamento das paredes exteriores seguiu o partido anterior, privilegiando o reboco da maioria dos paramentos.

The majority of the frames of the openings were new or rebuilt in the image of the earlier, which allowed the widespread use of double glazing and the adoption of appropriate shading.

3 different types of roofing were carried out: new roofs of reinforced concrete, metal or wood roofs and isothermal plates of lacquered aluminum.

The new roofing made of reinforced concrete, flat or inclined, were sealed, isolated and finished with a suitable superior wear layer.

The metal and wood roofs of buildings D, E and F (exhibition and historical archive) that were uncovered were repaired and treated with a cover with isothermal plates of lacquered aluminum, which on the inside also came into view keeping the factory character.

In the building A, the structure of the wood roof was reviewed and repaired being placed a timber liner and a layer of heat insulating material, followed by a new ceramic tile similar to the existing one.

Figure 3_ Permanent exhibition room (beheading room) – metal roof

Figure 19_ Temporary exhibition rooms – metal roof

Figure 20_ Temporary exhibition rooms – Wood roof

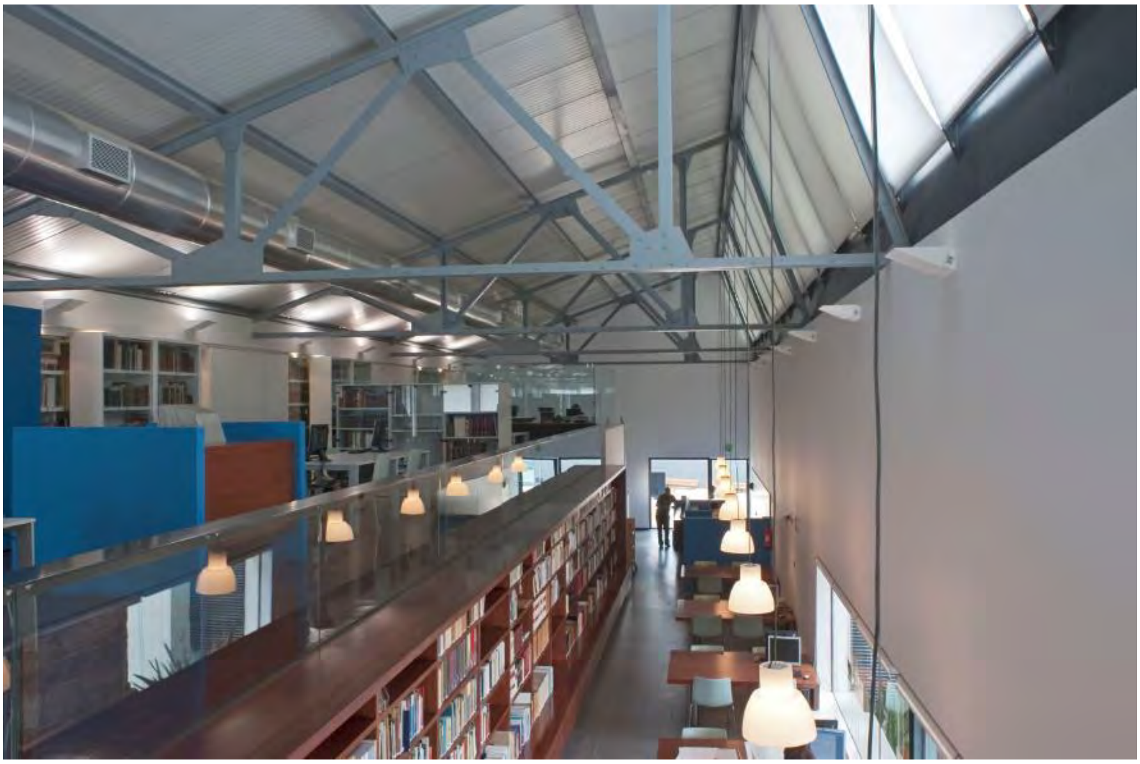

Figura 21_ Documentation center/historical archive – windows on the top and bottom for natural lighting

vi. Construction method

- Consolidation of foundations:

The foundations have been consolidated, through micropiles and in general, different solutions were adopted to improve the seismic behavior of the old structures.

- Masonry structure consolidation:

The existing masonry walls were unable to withstand stresses produced by perpendicular forces and thus have been created "diaphragm" in horizontal planes in order to transfer the reactions of the horizontal forces generated by the seismic action for the elements with higher rigidity. Within the walls were also constructed bracing elements of reinforced concrete.

- Restoration of coverage:

Terracotta titles have been completely replaced with new items similar to the original ones.

Figura 22_ Aerial view – rehabilitation works (2005-2006)

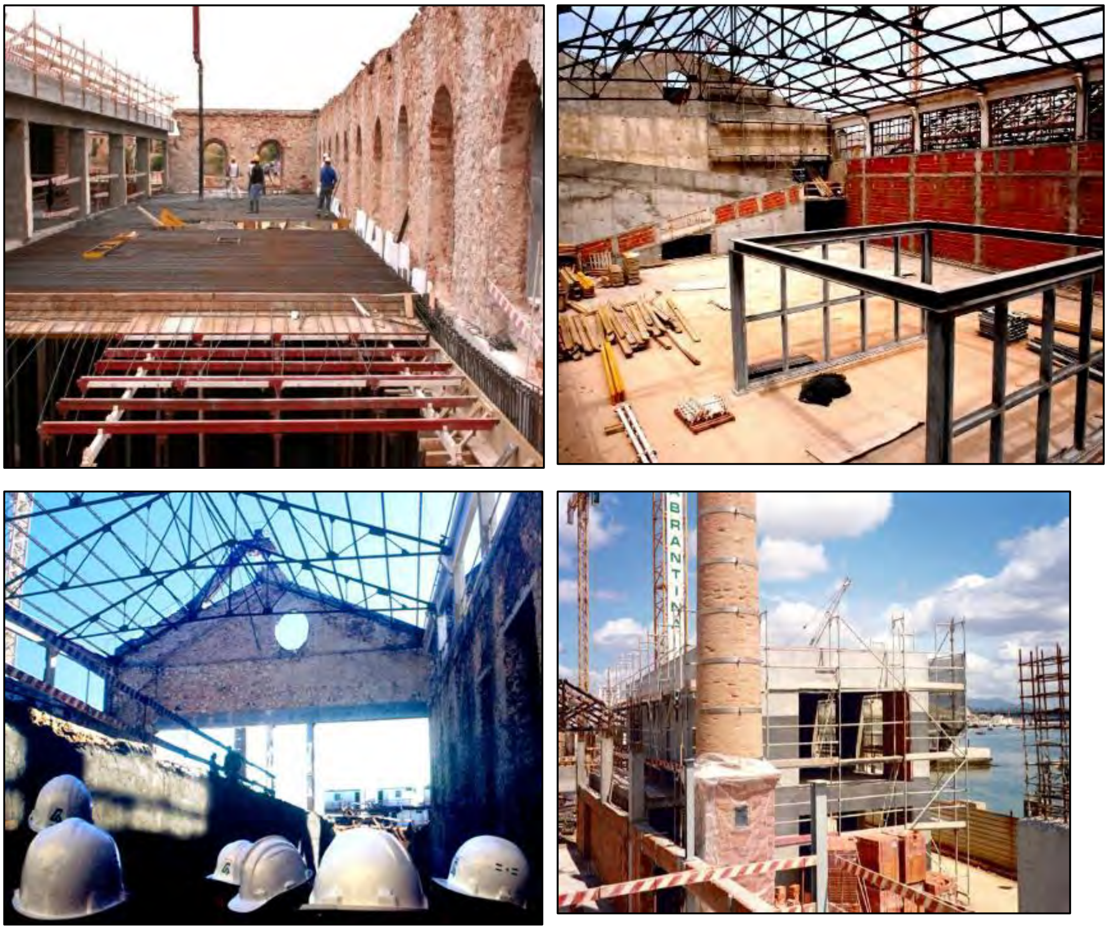

Figura 23_ Rehabilitation works - details (2005-2007)

vii. Short description of building

The spatial organization options were essentially as follows:

. main entry made by the river side (east) and in a central position;

. service entrance located adjacent to the south parking for easy access to heavy vehicles;

. permanent exhibition space occupying the large central factory building (Building D), with spaces for temporary exhibitions and Tecnoteca occupying the A2 floors of the building;

. reservations and technical area occupy the second largest factory building (Building E) and the lower level of the A3 building, standing on the top floor the administrative services.

. the building G, with coverage in shed receives the historical archive, being possible its independent access, or through the main entrance;

. the demolition of the buildings that were in worse condition (H and I), was essential to enhance the overview of the Arade river; to occupy part of this space was built a new volume, to be the snack bar, excellently located near the Marina and the main sectors of the Museum and close contact - visual and physical - with the riverside area;

. finally the auditorium, placed in buildings B and C.

Figura 24_ Plant functional scheme

Subtitle of the above plant:

1. Hall, public space for reception	7. Documentation center	13. Dark-room
2. long term exhibitions room	8. Reservations and support room museum	14. Auditorium
3. Fish-cleaning room	9. Educational workshop	15. Crane
4. Temporary exhibition room	10. Decontamination room	16. Esplanade, seafront
5. Technical area / support center for underwater archeology	11. Support and meeting room	17. Snack bar
6. Laboratory / Restauration workshop	12. Administrative services	18. Fish carrier

viii. Overall conservation status

The current general state of preservation is good. Rehabilitation of the building structures, mainly, steal and wood roofs, and the reinforcing of masonry walls allowed to keep intact the memory of

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the previous building without altering its conformation. Also taking advantage of a deep intervention thermal insulation materials were incorporate focused on energy savings and a better thermal performance of the building.

ix. Actual European Energy Standard

European legislation on energy efficiency in historic buildings does not require compliance with minimum standards, and grants the power of decision to the member countries. Thus, the legislation to any intervention on the heritage varies between EU member states. In Portugal the national regulations exclude monuments and buildings individually classified or to be classified, those that are recognized special architectural and historical value and buildings integrated in sets or classified sites or to be classified, or located within protection zones (DL 118/2013).

d. Urban Context

i. General description

The current urban center of Portimão dates back to the fifteenth century. At that time began the construction of its walls, which limited an irregular polygon, from the river to the interior. It was the sea who played a decisive role in its development. However, Vila Nova de Portimão, as it was called, developed an economy marked by three complementary and interrelated activities, agriculture, fisheries and trade. The origins of Portimão date back to 1463, with the establishment of people from Silves, on the right bank of the River Arade, under the name of St. Lawrence of Barrosa. The king regent, D. Afonso V, authorized the founding of this town with the condition of the people of Silves build home in this place and settle within two years. To facilitate the foundation of that new territory, the king attributed many advantages in taxation and exemption from going to war. Because of its great geographical location, trade developed and the population was growing. In 1495, King D. João II raised this location to village status through a charter. The name of this territory is changed to Vila Nova de Portimão. In June 1504 the "our honoured village" (as mentioned in the charter) received a New Foral, or Manueline, awarded by King D. Manuel I, recognizing their growing economic potential due to the special connection between land and sea (the mouth or Arade River). From then it becomes one of the polarizing centers of Algarve's economy. At the beginning of the sixteenth century, Vila Nova de Portimão was the 4th town in the Algarve coast.

In the seventeenth and eighteenth centuries Vila Nova de Portimão has been shaken by various economic crises, in more or less long and regular periods, inhibited the development of the Algarve region. It should be noted the damage caused by the great earthquake of 1755. Still, the Marquis of Pombal held its audacious project to make Portimão bishopric seat, raised its status to city and integrated Alvor within its boundaries. Alvor had just lost its village status due to the process of Távoras, which turned out to occur in 1773 and published in Chancery-Mor of the Court and Kingdom in 20 February 1777. However, with the removal of the Marquis of Pombal, the city of Portimão quickly returns to his village status. Vila Nova de Portimão suffered in the second half of the nineteenth century, an accelerated growth that created opportunities for its expansion, first through the development of dried fruit industry, and then with the implementation of the first fish canning factories in the last quarter of the century. The latter activity, together with other, already established in the village such as fishing and shipbuilding, would raise the status of Portimão, with the result that on December 11, 1924 the village was definitely considered a town, by the decree issued by the then President of the Republic, the well-known writer and businessman Manuel Teixeira Gomes, born in Portimão.

Portimão is a city strongly marked by its river and sea nature. Was enshrined in the twentieth century, as cosmopolitan center, at the beginning with a predominance of industry and commerce and later tourism. It was this tourist demand coupled with demographic pressure which imposed a fast pace of urban growth of the city.

Portimão is now a city full of life, with its own rhythm where development is based on a philosophy of quality combined with the progress. It is a reference in terms of economic development, especially as regards the quality of life of citizens. Noteworthy is the multiplicity of cultural and sports facilities that make this city a privileged stage for the implementation of major national and international events. The municipality has coherence and diversity - between coastal and inland, between the town and the villages of Alvor and Mexilhoeira Grande -

being able to offer various options to its residents and visitors. For all this, Portimão is currently considered the main city of the western Algarve.
But as it is not enough to proclaim himself, every day is committed to move from words to action and to enhance what was already reached, breaking the ways of the future.

ii. Analytic description

The "Portimão Museum" is located in the south of Portugal and the extreme west of Europe in a coastal town, bathed by two rivers, the Arade and the Alvor, which always allowed it to be an important link between the sea and the hinterland. Since the 60's/70's the municipality main economic activity is tourism, which has caused some considerable changes on the territory's landscape. But this was not the first movement of its kind. The town and the Arade river banks got its first, and huge, face-lift when industrialization arrived, in the form of fish-canning factories.
Fish-canning had a major impact on both banks of the Arade river, causing a huge change on urban, economic, population and social terms. In the heyday, there were 25 factories and its suburbs, which represented a huge leap, since we are talking about a time when there was no industry throughout the territory for a next step, in which abruptly appeared many companies with the need for huge workforce, which mostly came from neighboring towns and inland.
One of the main factories that labored on this great center of productivity was the Feu Hermanos, edified by Spanish industrialists on a strategic

location on the right bank of the Arade on the beginning of the 20th century. It worked till 1984, when the company went bankrupt, being abandoned until 1996. At that time, the Town Hall bought the plant in order to build the Portimão Museum to preserve the memories and the identity of the territory, in a time of rapid changes that have affected the urban landscape and the form of social organization. Portimão Museum opened its doors to the public in May 17th, 2008.

The building itself and its surroundings are also a memory milestone in the riverfront, a gateway to different cultures over the centuries. This was one of the essential elements in the renewal process. This included not only the factory but also elements such as fish carrier and the old harbour crane, which transported the containers full of cans of sardines from the factories to the ships that would take them to the world market.

The museum project aimed to keep the industrial heritage present as much as possible, keeping most of the factories original areas, with particular notes to the eastern façade, the chimney and the "Beheading Room", the room on which the fish entered the factory and would get its first treatment, consisting on gutting, beheading and brining, and where most of the workers were women.

The Beheading Room is one of the highlights of the permanent exhibition, which is divided in three big moments:

- Origin and destiny of a community
- Industrial life and the challenge of the sea
- Under the waters.

Here, mostly on the last two, one can observe the close bond between the municipality and the activities linked to river and the sea, like fishing, shipbuilding and the fish-canning industry using, besides the aforementioned room, the main industrial hall.

In addition, the museum also offers other services. One of the most important is the educational component. The museum welcomes groups and classes of schools, associations, families and provides various activities for the users to explore creatively most of the themes in the permanent and temporary exhibitions, and on local history. The educational services has its own room, fully equipped with all the tools necessary to allow interaction with different materials like water, ink, or sand. All these activities are compiled in an annual program that includes activities also in the Easter holidays and summer vacation. The education department also includes a historical recreation in the prehistoric site of Alcalar, composed of role playing and pottery workshops, hunting, baking and many others.

e. LOCAL CLIMATE DATA

i. General description

Mediterranean climate

Climatic Zone I1 V1

ii. Analytic description

- 940 degree days (base 20 ° C)
- 5,3 months - the duration of the hot season

- External temperature of the project - Summer 31 ° C
- 11º C temperature range

f. Energy Demand

i. Building Energy performance

The energy needs of winter heating and summer cooling of a building depends on several factors: the climate, the architectural orientation, thermal insulation, the type of heating system, sunlight and internal contributions as well as other parameters such as the occupant's activities.

ii. Requirements

The thermal comfort conditions considered for the majority of the building were those imposed by the Regulation of Energy and HVAC systems in buildings (DL 118/98):

- Summer: 25ºC, 50% HR
- Winter: 20ºC, 50% HR

Given the need for energy savings, these values should be regarded as minimum guidelines for summer and upper limits for the winter. Depending on the outside temperature it is assumed that the indoor temperature may rise to 27 ° C in the hottest summer days and down to 18 ° C in the coldest winter days.

In the Historical Archives, the conditions of temperature and humidity are expected to remain stable throughout the year and throughout each 24-hour period. The temperature can vary between 18ºC and 20ºC, and the relative humidity should be maintained in 50% ± 5%. These conditions are favored by the fact that this is an interior room without windows and with reduced internal loads. The introduced air is suitably filtered using a 3-stage filtration. Because there are no more than 2 or 3 employees in this room is possible to limit the flow of fresh air (from outside) to about 0.5 renewals / hour, as a way of saving energy.

iii. **Passive measures**

- Good insulation and caulking in order to minimize heat gain in summer and winter losses;
- Insulation of floors, in which were placed cooling systems and radiant heating (atrium, permanent exhibitions area).

iv. **Cooling and heating production**

- The proximity of the Arade river is exploited as a cold water supply that allows cooling or pre-cooling of various areas of the Museum.
- Use of production units of ice water, which also allows the production of hot water (heat pump with energy recovery).

v. **Climate**

- Air recirculation facilities were reduced in order to avoid the proliferation of contaminants.
- New air treatment units have been used, the air being suitably filtered and pre-cooled or preheated.

- Cooling and heating through underfloor heating.

vi. **Air renewal**

- In areas of placement was considered a rate of 30m3 / h per person with a minimum of 0.5 air renewals / hour.
- In areas with production of pollutants was considered an air renewal rate of 3 / hour.

The use of the Arade river water for cooling

To enjoy the water of the river, was carried out:

– A work of water collection, 10m deep, in order to ensure a water temperature of 16ºC to 18ºC,

– The installation of water circulation pumps with pre-filters and installation of closed sand filters, sized for a filtration rate of 20 to 25m3 / h.m2.

The water circulation system is made in open circuit. The pumped water from the river feeds the cooling loops installed in the floors and the outside air pre-cooling coils installed in the New Air Handling Units (UTAN's).

Cooling and heat production

The production of cold and heat is provided by 2 chillers with heat recovery, ie with the possibility of simultaneous production of cold water and hot water. This choice was due to the fact that the dehumidification process often require the cooling, followed by heating to adjust to room temperature. With this equipment, whenever there is need for cooling, heating is free.

Air handling units

Air handling units were considered for the following areas:

- Permanent exhibitions area
- Historical archive storage
- Research and reading room
- Reservations Area
- Administrative Area
- Atrium

2 GENERAL OBJECTIVES

The rehabilitation works had the following assumptions:

a) the minimum possible changes, maximizing the use of its structural logic and pre-existing spaces;

b) Flexibility that allows replacement of equipment, adapting them to new uses and to different operational requirements;

c) Ecological intervention, both in terms of construction and in terms of functioning, avoiding the use of excessively specialized equipment and technologies with high maintenance costs;

d) Energy saving and "information management";

e) Insurance of comfort (thermal and hydrothermal) in different spaces;

f) Integration between new technological improvements and the existing building.

3 REFERENCE

a. Museu de Portimão: http://www.museudePortimão.pt/en/default.aspx
b. Virtual Visit: Discover the musean from your home http://museudePortimão.pt/externalPages/visitavirtual/Entrada_Recepcao.swf

4 AWARDS AND ACKNOWLDGE

The museum has been awarded some distinctions since its opening with a focus on winning the 2010 Council of Europe Museum Prize and the 2011 DASA-World of Work Museum Award.

We acknowledge the director of the museum, José Gameiro, and his team all the information and explanations provided.

EH-CMap
Advanced Training on Energy Efficiency in Historic Heritage

CASE STUDIES DATA SHEET

PALAZZINA DELLA VIOLA, BOLOGNA (ITALY)

0 KEY WORDS

Use of red Bolognese curtains

Overshadowing - The building is shaded by trees on all sides except the South side (main facade) where there is a meadow. Trees partially shade the roof.

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1 TYPE OF INTERVENTIONS

a. GENERAL INFORMATION

i. Location

Palazzina della Viola
Via Filippo Re, 2 - 40126
Bologna (BO), Italy

GPS: 44° 29' N / 11°20' E

The site is located in via Filippo Re, near the old city walls of Bologna. It is an university area with a high rate of students' participation with pedestrian and vehicular traffic. Via 'Filippo Re' is a dead-end street and it is characterized by University buildings surrounded by public parks.

Figure 1_ Territorial framework

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i. **Regulation Constrains**

- Local legislation: Urban Building Regulation Protection status: the building is qualified as building of historical and architectonic interest in the Urban Regulation Code and therefore admits only respectful interventions of renovation and maintenance.
- The subject in charge of the object, qualified as building of historical and architectonic interest in the Urban Building Regulation Cod, is the local Authority for Cultural Heritage.
- The typologies of intervention and modification admitted are described at the art. n. 57 of the Building Regulation Code, specifically with requisites nr. IS 1, 2, 3. In particular, the Regulation Code prescripts to preserve the original integrity of every architectonic, artistic and decorative elements of it.
- Development plans: the building is placed in the "Comparto Filippo Re" of Bologna, between the old city walls and the Botanic Garden. The urban context is under redevelopment and the rehabilitation of this area is part of the Agreement between the University and the Municipality of Bologna. Ownership: Alma Mater Studiorum - Università di Bologna.
- Ministry Decree of 22nd/2/2006 on fire prevention "Technical regulation for fire prevention within design, construction and functioning of buildings or indoor spaces dedicated to offices".

- Ministry Decree nr. 569 of 20th/5/1992 on fire prevention in historic buildings "Safety rules for fire prevention and protection in historic buildings hosting museums, galleries, expositions and exhibitions.
- Guidelines for the evaluation and reduction of seismic risk in cultural heritage – alignment to the new Technical Code for buildings" Act nr. 26 of 2nd/12/2010.
- First Minister Directive Guideline for the evaluation and reduction of the seismic risk in cultural heritage of 12th/10/2007.
- The classification of the building is based on the existing national and regional codes also for the evaluation of the acoustic comfort, and in particular:
  - At national level the Framework Law n. 477/95 and its executive decrees DPCM 14/11/97 and DMA 16/3/98;
  - At regional level LR 9/5/2011 and "Direttiva regionale 2053/2001";
  - At local level "Acoustic classification of Bologna communal territory" ODG n°42 of 20/1/2010.

i. Protection/Conservation status/level

The building is located in the "Comparto Filippo Re" of Bologna between the old city walls and the Botanic Garden. The site is characterized by the presence of other historic buildings (mainly from 1900) connected by pedestrian paths and parking for university staff. Buildings are surrounded by green areas with trees.

Regarding energy-related aspects, it consists in a self-contained building, South-East oriented, shaded by trees on all sides except the South side.

As above-mentioned the rehabilitation and refurbishment interventions had to follow the Urban Building Regulation Code. Also the works have been undertaken in order to improve the safety performance of the building taking into account seismic risk.

Certificates about static regulations have been the care of the technical office of the University as project Director. All was accomplished as requested by the current regulations for interventions.

The Explanatory Technical Survey contains the information in relation to the building typology and explicitly indicates the dimensions and functions of the intervention and the context in which it has been carried out.

Fire extinguisher and all required equipment for protection from fire risks have been provided and installed as from up-to-date Italian laws.

In relevant parts of the ceilings between ground and first floor, during the renovation project, the structural performance with regard to seismic safety has been significantly improved by means of more complete anchoring of the ceilings with the

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respective perimeter walls. In the structural nodes of the timber elements of the roof, trusses, tightening between the elements has been improved by fastening. This was aimed at improving the box behavior of the building.

The whole building has been studied and has undergone refurbishment and rehabilitation works.

b. General Description _ Before Restoration

i. Date of construction

1497

ii. Architect

Giovanni II Bentivoglio.

Frescoes and painted wooden ceiling by Amico Aspertini, Prospero Fontana and Innocenzo da Imola (15th and 16th C.)

Figure 2_ Architectural Style: Renaissance

iii. Architectural style/styles

Renaissance.

This building has a high cultural and architectural value and for its peculiarity it was defined a jewel of the Renaissance art.

iv. Construction phases

Phase 1: 1497. The building was the College for the University of Bologna students who came from Piedmont (a northern region of Italy) from 1540 to 1797.

Phase 2: 1907. Having been acquired, in 1803, together with the land plot around it by the Government of the Italian Republic to host the Faculty of Agriculture and the Botanical Garden and the building has been object of rehabilitation intervention at the beginning of 1907. Minor interventions were also done in 1928.

Figure 3_ Archive photo, front view of Palazzina in 1922

Phase 3: After the 2nd WW the N-W corner of the building was rebuilt because destroyed by a bombardment. Several other partial remakes date from the last 60-70 years.

Phase 4: Rehabilitation preservation interventions and functional requalification has been started at the end of 2010.

v. Original use

Hunting hut.

vi. Construction materials

.Brick masonry

.Wooden roof structure

.Steel

vii. Construction method

- Masonry construction:

Light building, load bearing masonry with ceilings made of steel, wooden beams and brick elements.

This isolated building, built in 1497 as little hunting hut, has a quadrangular plan (4 floors,300 m^2 per floor, around 4240 m^3 of total volume) and 3 facades (partly plastered) lightened by a double open gallery. It has three floors above ground and one basement floor. It has 38 rooms.

The covered area is 500m^2 each floor, the gross area is 1.310m^2 and the net area is 1.061m^2. The heated surface is 833m^2 and the cooled surface is 752m^2. The heated volume is 3.561m^3.

The structure is load bearing masonry walls and ceilings made of steel beams and brick elements. The building is enriched at the ground and 1st floor, by frescoes and painted wooden ceilings (15th and 16th C.), attributed to Amico Aspertini and Prospero Fontana.

The ceilings, originally timber beams ceilings, were partially substituted for metal beam ceilings with hollow fired-clay elements or for on-site cast prestressed concrete beams with hollow fired-clay elements.

- Facades and Roofs

The building presents a pitched roof and three glazed facades.

The main facade (South-East) presents a porch at the ground level with a loggia on the upper level. The roof structure is made of wooden beams, partly original and partly new. The roof is made with 40mm thick terracotta elements covered with a waterproof membrane on which the roof tiles have been laid.

  - Facade 1

The main facade is the South-East. The type is Porch at the ground floor & glazed facade at the 1st floor. The porch protects the rooms of the ground floor.

Figures 4, 5 and 6: Perspectives of the main facade.

Very many types of windows can be recognized; they are of different materials (wood, steel...) and from different ages. Moreover different types of glasses can be identified: normal (thin, thick), printed (stripes, different shapes and size of prints) and coloured (milk).

All the exterior windows are characterized with clear glasses, single or double.

Dimension of frames, glasses, depths, and other main characteristics were collected following the directive of PHPP and in order to produce a good amount of information necessary to understand and maintain the history of building and to analyses correctly the energy balance.

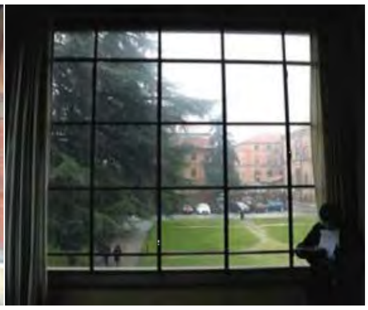

Figure 7_ WGF28 Figure 8_WF127

Facade area: 193,76 m^2.
Windows area: 104,18 m^2.

- Facade 2

This facade is the North-East side. The type is double glazed facade.

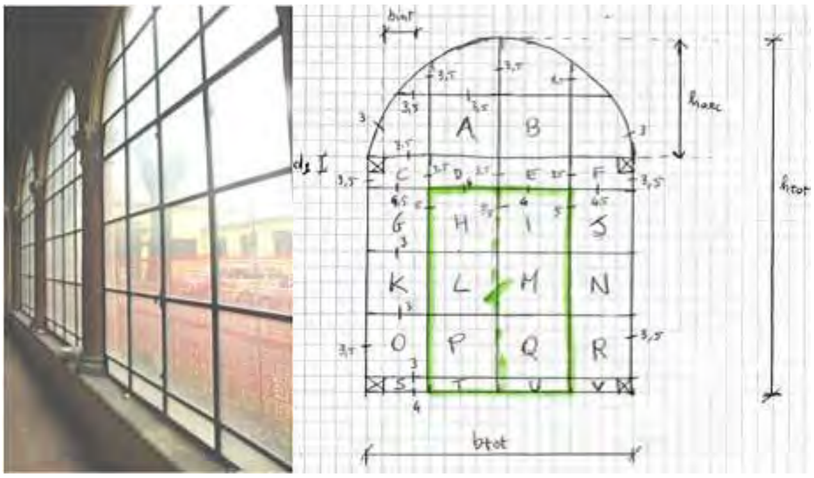

Figure 9 and 10_ Photo and sketch WGF1, ground floor


Figure 11_ WGF6, ground floor


Figure 12_ W1F2, first floor

Facade area: 176,92 m²
Windows area: 85,48 m²

- Facade 3

This facade is the North-West side.

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Figure 13_North-West Side.


Figure 14_W1F9

Facade area: 187,71m²
Windows area: 56,02m²

- Facade 4

This facade is the South-West side. The type is double glazed facade.

Figure 15_ View from the South corner

Facade area: 182,09m²

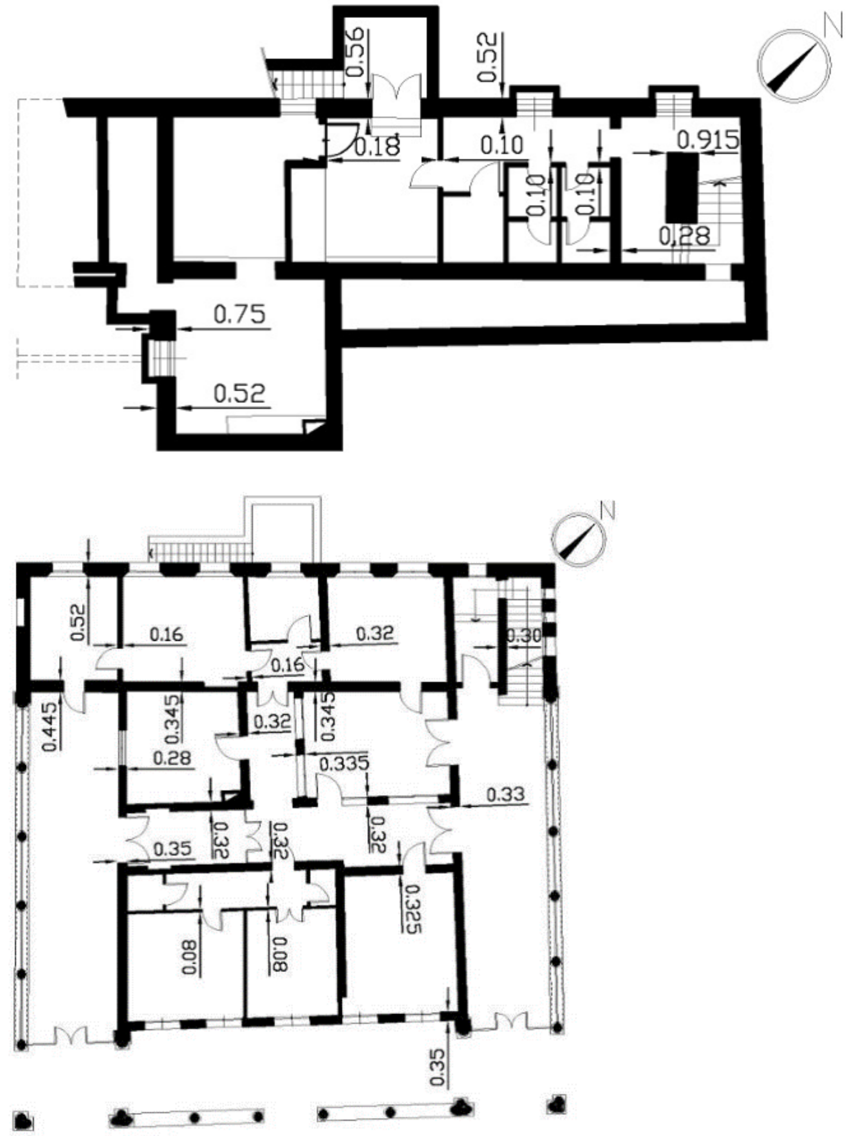
Windows area: 90,62m²

- External walls

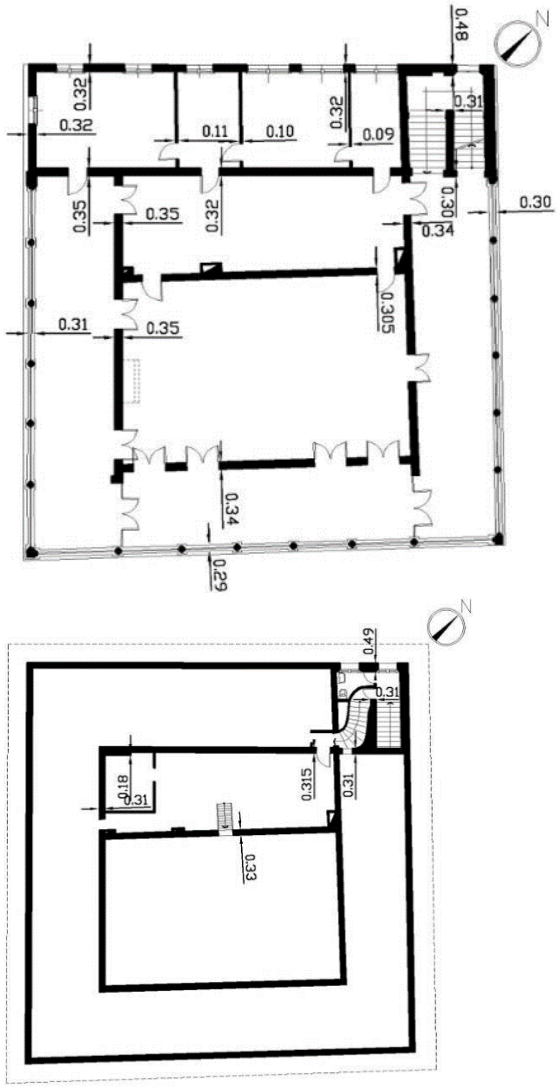
The thicknesses of the main walls are reported in figures 16 and 17, but it is necessary to underline that the thickness of the majority of the walls, especially the older ones, is not constant throughout the building, also because the plaster thickness is uneven. The measurements reported for each wall, resulted from measures in multiple locations of the same wall, with an approximation of about ± 0.5 cm.

All bearing walls of the Palazzina are made of solid masonry. Some existing cavity related to the presence of old chimneys have also been found.

No membrane for humidity control transportation was present into the walls.



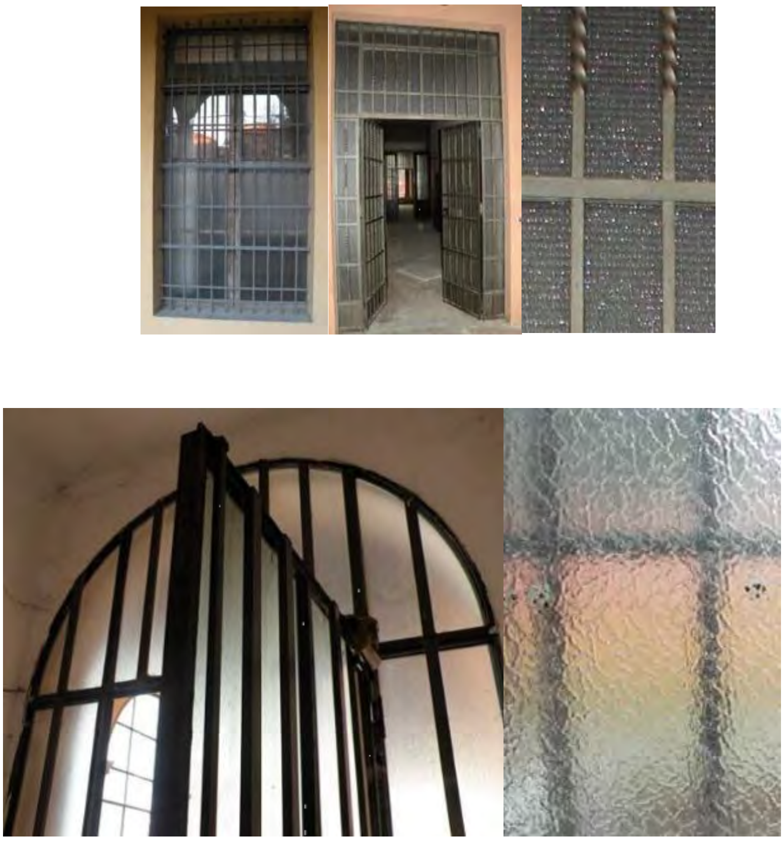
Figures 16 e 17_ Plan view of underground and ground floor showing the thicknesses of the walls



Figures 18 e 19_ Plan view of first floor and second floor showing the thicknesses of the walls

- Windows

The Palazzina della Viola is characterized by a large amount of windows with a percentage of windows area related to the total surface area very high. In the following images, some example photos are reported to show the different types of windows frames and glasses installed in the building. Note that all the exterior windows are characterized with clear glasses, single or double, while interior doors and windows have often printed glasses.



Figures 20, 21, 22, 23 & 24_Different types of windows (windows frames and glazing) installed.

Figures 25, 26 & 27_ Details of the window frames of the first floor

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Figures 28 & 29_ Internal glazed doors

Numerical simulation of as-in-state conditions of window frames

The study of performance of old windows was carried out by ARUP. The numerical simulation had considered two different, representative, windows of the South facade, one at the ground floor and one at the first floor.

The purpose of the study was to characterize the actual thermal behavior of components and the interaction with the room climate conditions.

The renovation project included the restoration of existing windows, not allowing for the replacement (due to heritage protection constraints).

WGF24 – Details:

Environmental Conditions:

- Internal Temp.: 8°C (from psychrometric map)

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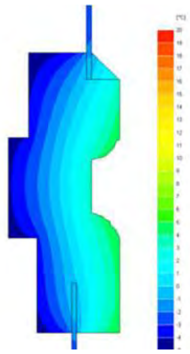
- External Temp.: -5°C

Ψ-value: 2.70 W/mK

Min. Internal Surface Temp.: -1.3 °C



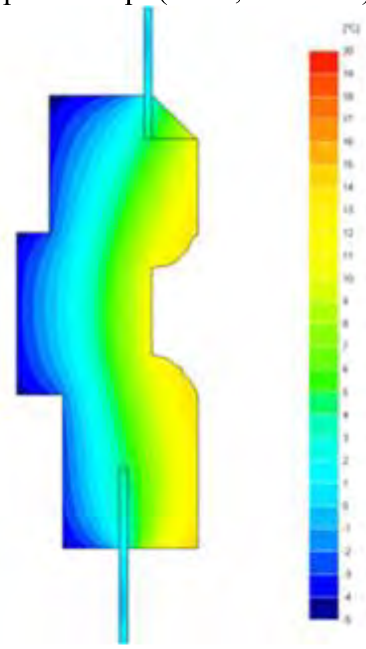
Environmental Conditions:

- Internal Temp.: 20°C (design temperature)
- External Temp.: -5°C

Ψ-value: 2.70 W/mK

Min. Internal Surface Temp.: 2.5 °C

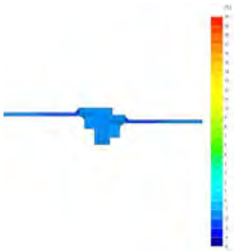
Dew point temp. (20°C; 50% RH): 9.3 °C



Formation of Condensation

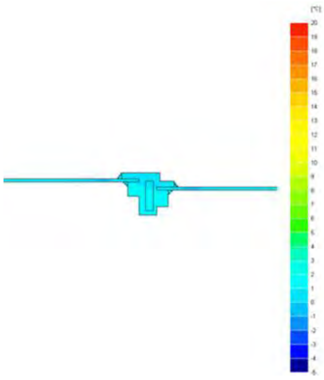
W1F24 – Details:
Environmental Conditions:
- Internal Temp.: 8°C (from psychrometric map)
- External Temp.: -5°C

Ψ-value: 2.64 W/mK
Min. Internal Surface Temp.: -1.9 °C



Environmental Conditions:
- Internal Temp.: 20°C (design temperature)
- External Temp.: -5°C

Ψ-value: 2.64 W/mK
Min. Internal Surface Temp.: 1.0°C
Dew point temp. (20°C; 50% RH): 9.3 °C



- Rooms and room units

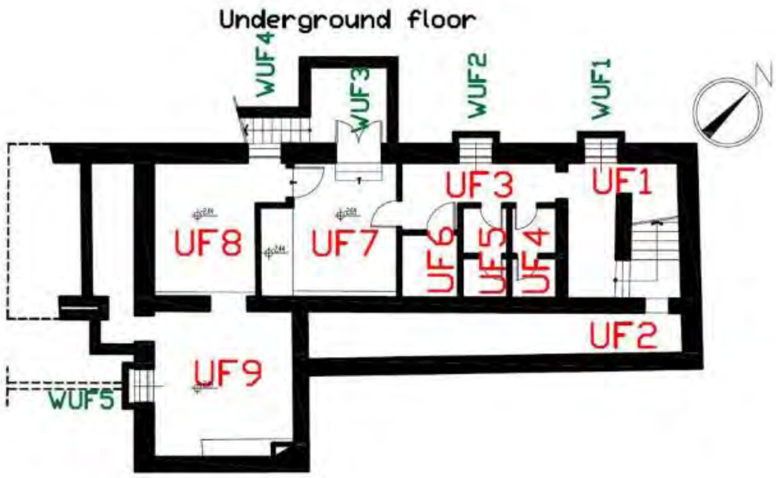


Figure 30_Underground floor

Almost all the building has no foundations and there is a layer of gravel about 50 cm below the floor (this can be determined by the destructive openings carried out on the floor of the building's ground level in several places). At the rear side of the building is instead present a basement that serves in part as a foundation. From this, an access to a vaulted opening can be gained, that shows the shape of the building underground structure. The presence of voids under the building partially filled with earth and gravel has to be noticed. In addition, the structure is supported by arches that can be supposed to be extended to the remaining basement structure. There is no historical information about the foundations, but the hypothesis of the presence of cellars and underground passages is governed by the evidence found on many of the historic buildings of the city. Following the destruction of the North East wing in

World War II it was chosen to close the cellar spaces for further consolidation of the foundations.

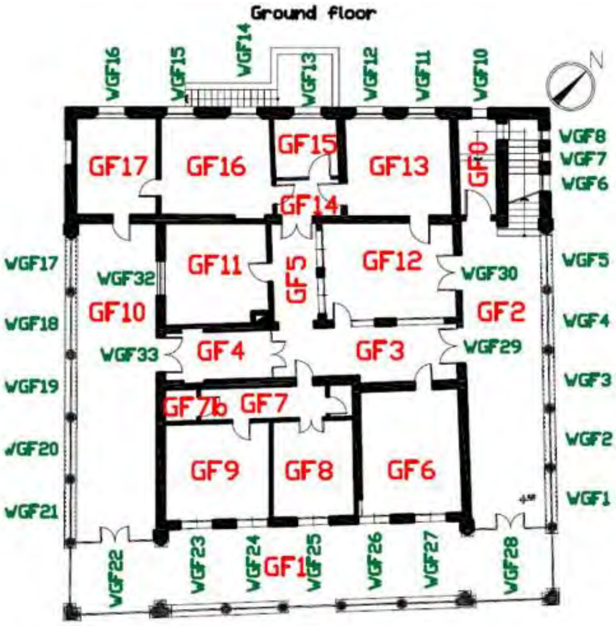


Figure 31_ – Ground floor

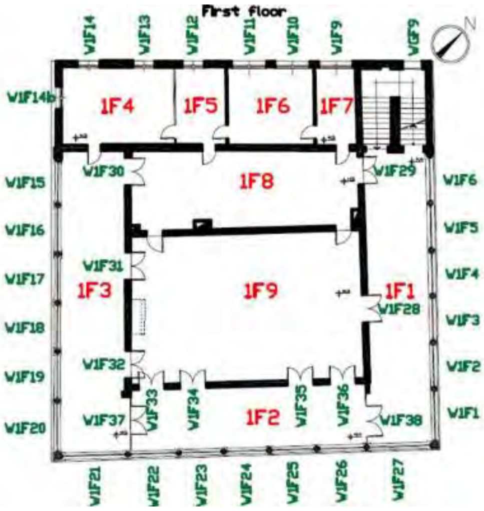


Figure 32 _ First floor, The Large Hall

The large hall, the most representative room of the building, is placed in the center of the 1st floor and yields a volume of about 670 m^3. It is has an high historical value as it is characterized by completely frescoed walls, The large hall does not have direct opening to the exterior but natural light and air are entering from 6 wide French doors, 4 of connection to the front loggia (1F2) and 2 connecting with the S-W loggia. Dimension: length: 13.3 width: 8.6 height: 5.9 unit: [m].

Loggia (front)

The loggia on the front at the first floor has only one masonry wall and the other three walls made of glazing. It has a high cultural value, as it presents a painted timber ceiling and the masonry wall is frescoed. Dimension: length: 13.7 width: 3.5 height: 4 unit: [m]. Planned use: meeting room.

The room greatly suffers from greenhouse effect, having only one masonry wall and the other three walls made of glazing, thus it is undergone to strong temperature excursions.

The light amount tent to be always excessive, with high preservation risks for the decorations, and uncomfortable conditions - including glaring - to users.

- Internal partition

Vertical Opaque walls

All old walls are made of solid masonry, except for few partition walls inserted in the last period made of hollow bricks. The difference is also easy to view by observing the plan view below: there are big differences in thickness between old walls and new partitions. In some parts of building, walls are covered by frescos or frescoes may be found below the painting layer.

For information about thickness and technical data of material is possible to see some measures from plan view in the figures below.

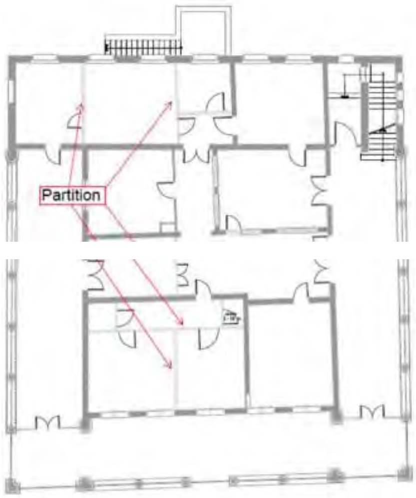


Figure 33_ Partitions at ground floor.

Figure 34_Plan of frescoed areas in building

Figure 35_Vertical opaque walls in the ground floor (top) and 1st floor (bottom)

- Ceilings

There are a number of different ceilings. This has happened because some interventions during the time have attempted to preserve some precious wooden ceiling and coffered ceiling, by putting modern ceilings with steel beams and brick infill on top of original timber ceilings. In figure below are shown the main types.

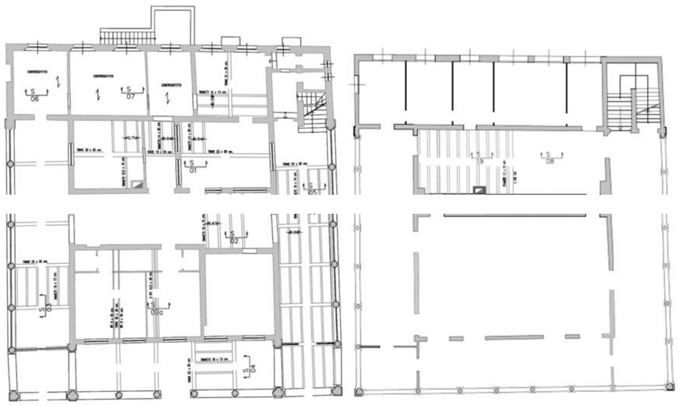


Figure 36_ Plan view of ground floor and first floor with openings' positions (used to examine the floors' structure).

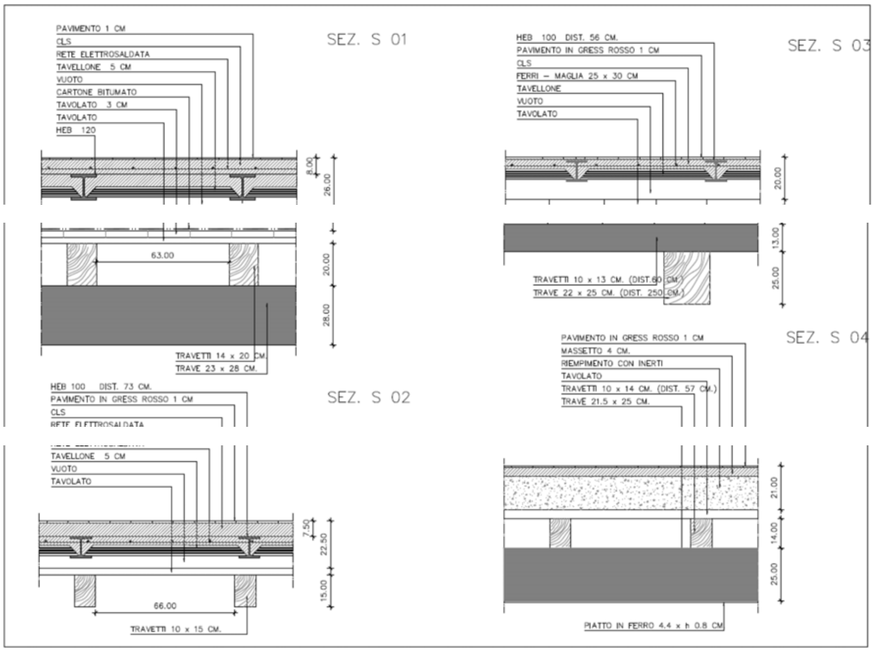


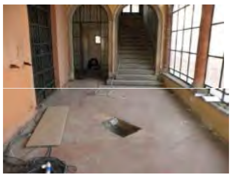
Figure 37_ Internal views of the wooden roof structure

- Basement

Almost all the building has no foundations and there is a layer of gravel about 50 cm below the floor (this can be determined by the destructive openings carried out on the floor of the building's ground level in several places). At the rear side of the building is instead present a basement that serves in part as a foundation. From this, an access to a vaulted opening can be gained, that shows the shape of the building underground structure. The presence of voids under the building partially filled with earth and gravel has to be noticed. In addition, the structure is supported by arches that can be supposed to be extended to the remaining basement structure. There is no historical information about the foundations, but the hypothesis of the presence of cellars and underground passages is governed by the evidence found on many of the historic buildings of the city. Following the destruction of the North East wing in World War II it was chosen to close the cellar spaces for further consolidation of the foundations.

Figure 38_ Plan view of the underground floor and a detail of the floor (red position in the plan view).

Figure 39_ Plan view of the Ground floor



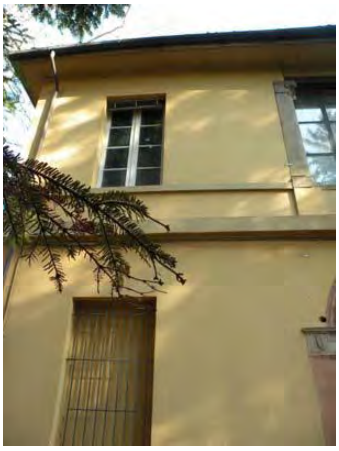

Figures 40 & 41_Ground floor pavement, NE side, and detail of a floor opening

The microclimate of underground floor is constant during the year with fresh and humid air, so theoretically considering only this aspect is possible to used temperature gradient between underground ambient and upper zone building. In reality is impossible because this option conflicts with the choice of designers that have defined the intended purpose of the basement for the toilets. However is possible to use the tunnel or use heat exchanging with the ground putting an exchanger in the land surrounding the building.

- Shielding (internal and external)

The trees surrounding the building are shading its facades; another shielding element is represented by the roof structures and the porch in the main facade. In addition some few windows of the ground floor present internal shielding elements. Examples are reported in the following figures. The shading systems are mainly curtains, in all windows except in glazed porch at NE and SW sides. There are also cornices in all side, but not very large. In the South facade there is a porch that protects room of ground floor.


Figure 42_Shading in the main facade Figure 43_View of the trees from above




Figures 44 & 45_N-W facade: examples of shading due to trees and roof in two different climatic conditions (a sunny and a cloudy day)

On rear windows interior wooden shutters are mounted directly on the frames, such as are showed in figure below.

Figure 46_ Shading system on a window of the ground floor

c. General Description _After Restoration

i. Date of restoration

Nov. 2010 - March 2012

ii. Architect

Beni Artistici di Bologna, Architect(s) in charge of the conservation intervention.

iii. Typology of building

Light building, load bearing masonry with ceilings made of steel, wooden beams and brick elements.

iv. Present use

Offices of the International Relationships Department of the University of Bologna at the ground floor and spaces for congresses and events at the 1st floor.

v. **Structural analysis and assessment of moisture**

- Status of conservation

In October 2010, prior to the rehabilitation interventions there were several structural problems, conservation problems for the frescoes (related to indoor humidity, temperature and lighting) and problems related to energy efficiency (e.g. wide surface of windows, windows with single glazing). Cracks on walls and ceilings, salt rising in masonry walls, lack glazing, broken windows were visible.

After several years of abandon the rehabilitation procedures, preservation interventions and functional requalification took place from Nov. 2010 to March 2012.

- Structural analysis:

The structural analysis has started from a geometrical survey to check the dimensions reported in the available plans and views. For this reason the thicknesses of the walls at different levels were measured and the results are reported in the plan views below, with different colours. It is possible to see the presence of historical external and internal load-bearing walls with a thickness that vary from 30 to 50 cm and non-load bearing walls of more recent construction.

The building presents some structural problems as cracks in walls, ceilings and floor at different levels, especially in the South-West side. (Figure 47).

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Figure 47_ Cracks on the exterior walls in the SW side (left and centre); measurement of the air-flow through cracks from the interior with an anemometer (right)

In this case the survey and drawing of the crack pattern is very important and it has been conducted in order to better understand the state of damage of the structure and its vulnerable points. An example of a sketch of the crack pattern recorded on-site is given in Figure. 48.

Figure 48_ Crack pattern survey on a vertical section

Moreover, some of the opening and movements of cracks are being monitored by using different systems as shown in Figure. 49.

Figure 49_– Monitoring of cracks

Other structural problems are related to the wooden roof structures, made of ancient, original and new timber elements; the main problems are due to the water leakages as visible in Figure 50.

Figure 50_– Water leakages on the wooden beams of the roof.

- NDT testing for moisture detection

NDT tests, like GPR Radar or IR-thermography have been conducted in different position, both on exterior and interior walls of the building in order to detect the presence of moisture. Examples of GPR radar test and thermography tests are given in Figures 51 and 52.

Figure 51_GPR radar for moisture detection: vertical survey line on a masonry wall (left) and the collected radargram (right).

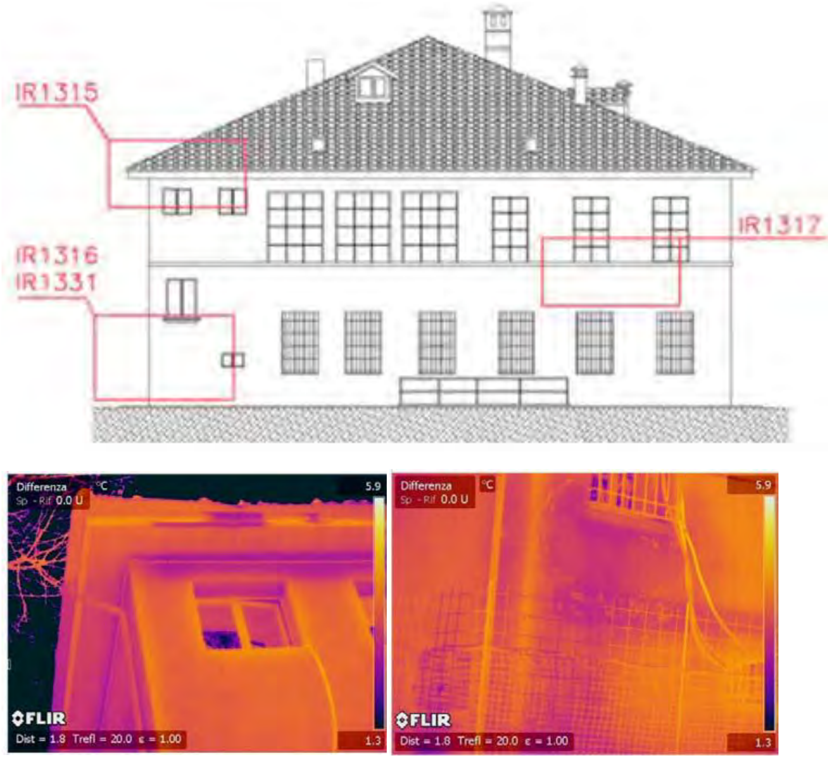

Figure 52_IR-thermography for moisture detection, exterior wall, rear side of the building

- U-value determination in historical buildings

Different U-value measurements have been conducted in a direct way in accordance to the norm ISO 9869, in order to compensate the lack of existing documentation on the actual state of the building and to obtain a sufficiently reliable estimation of the heat losses of the structure, keeping in mind that the physical characteristics of masonry's components are different from masonry's components currently used, thus the scheduled values should not be used. The U-value measurements positions are reported below, on the plan views of the building (Figure 53).

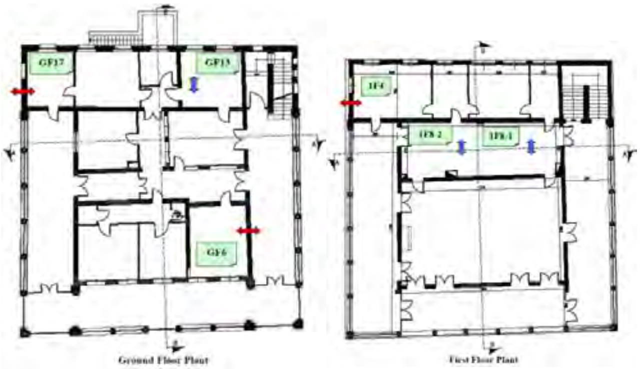

Figure 52_Plan view of the ground and first floor, with the position of U-value measurements

Legend:

Transmittance measure on ceiling between underground-ground floor and second floor-attic.

Transmittance measure on walls.

Room's code: GF6

- Airtightness in old buildings

Old buildings are often characterized by a great amount of thermal losses and a low airtight level. In our case study, Palazzina della Viola, the old original doors and windows presents bad airtight conditions as reported in the following interesting images.

Figure 53_Window frame around a masonry column (left) and detail of the opening (right), 1st floor, front side of the building.

Figure 54_Main entrance door in low airtight conditions, as visible from the passing light at the bottom

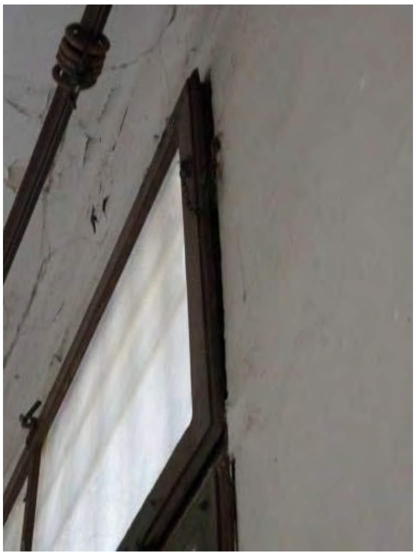

Figure 55_Detail of a window of the ground floor with a “bad closing”.

- Blower door test in old buildings

The blower door test has been carried out on April 2011. Due to the large volumes and the presence of air losses from windows and ceilings, it was not possible to perform one test for the whole building but it was necessary to divide the Palazzina into small areas.

Figure 55_Phases of the blower door test

- Hygrothermal and environmental monitoring

Repeated measurements of the environmental parameters (air temperature and relative humidity) have been carried out with portable instruments in different ways:

- climatic parameters have been collected through instantaneous reading at the centre of each room,
- a continuous monitoring for 24/48 hours period in the centre of rooms,
- after closed/open doors and curtains,
- at the discrete nodes of grids marked on floors, in each room in order to create psychrometric maps (an example of results is reported in Figures 56 & 57.

Moreover the surface T of walls has been measured.

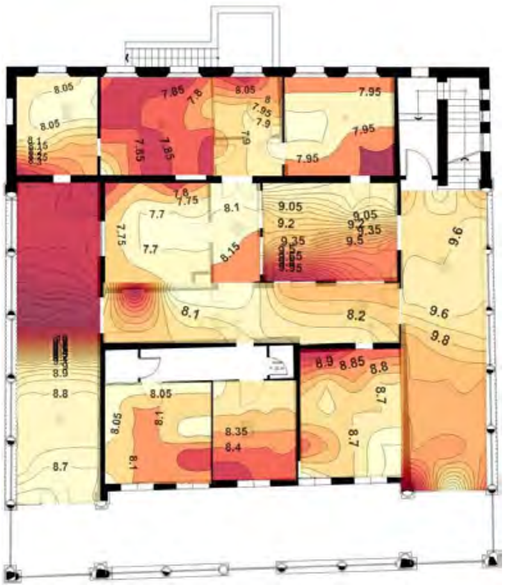

Figure 56_Psychrometric map of the temperature, ground floor (with all doors closed)

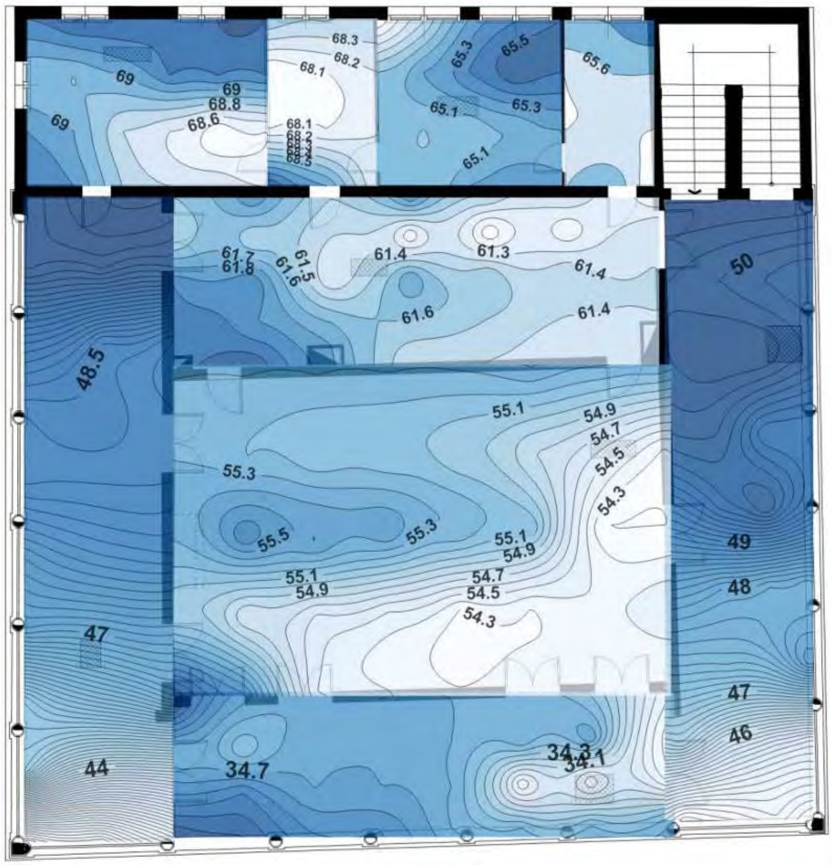

Figure 57_Psychrometric map of the air relative humidity, first floor (with all doors closed)

- WSN Monitoring system:

The monitoring system is based to a state of the art Wireless Sensor Network, which has the following characteristics:

- Dimensions: 100 X 56 X 29 mm
- 32bit 32Mhz fully programmable Microcontroller
- 2.4Ghz IEEE802.15.4 radio transceiver
- Temperature and relative humidity sensor

.Resolution of 0.01°C – 0.04 %RH

.Accuracy of ±0.3°C – ±2% RH

– Ambient light sensor:

.Resolution of 0.23lx

.Range (0 – 100000 lx)

– 3-axis ±2g/±6g linear accelerometer

.Resolution 1mg

– Multi brand full controlled MOX gas sensor interface

.Gas measurable VOC, CO, CO2, NOx, O3, NH4

– Micro SD card reader
– Expansion connector for extra analogue input channels, extra digital sensors and interface with several system by RS422, RS232, USB, RS428, UART, I2C, SPI. The connector provide 1.5W power supply.
– Battery charge circuit for supply the device with energy harvesting system (i.e. Solar panel, wind turbine, vibration, heat flow) or USB port.
– Multi-chemistry battery support (Standardized for AA battery format).
– Sleep power consumption 8uA Selectable acquisition rate (continues to 1.5day).

The network has been installed in February 2011. The network firmware will be updated constantly to improve the network deployment easiness, the availability of new feature and improve the battery life. Moreover the WSN node will be extended with external sensors for surface climate detection.

- Results derived from the application of PHPP

The results of the application of PHPP analysis for the pre-intervention scenario are presented in the figure 56 (above). In according with the features of the building, the main energy lost is related to the windows. The losses through exterior wall, the attic and due to infiltration are consistent. The lost through the attic is contained into Non-heated area, the infiltration effect is estimated in the ventilation component based on the blower door test measurement realized on the building. The mean air change rate at 50 Pa is 10. Also transmittance measurements were done to characterize some wall construction. The building was not used for several year and information related to the utilization were not provided. We considered just 20 persons without taking in account equipment consumption. Therefore primary energy is related to the heating system. Since the air changes were very high the building was totally climate driven, especially during summer.

The PHPP was repeated also after the retrofit in order to evaluate which was the improvement of the chosen intervention from the energy point of view. The focus of the project manager was concentrated more of the conservation of the building but some aspect of the energy efficiency were taken in account.

Also in this scenario, an energy certification is useful to do some consideration on the strategy implemented, for future improvement of the same building and for other refurbishment project in general.

After the intervention the losses through the windows, exterior wall and attic remain considerable; the values are very close to the pre-intervention scenario. The Ventilation component drops down due to the reduction of the infiltration. The air change rate per hour drops down from 10 to 5. According to the intervention, the airtightness level is improved with the restoration of the windows.

Considering the overall assessment, the heating and the cooling load are reduced of 12 and 30% respectively, the heating and cooling demand of 6 and 31 %. The overheating during summer is removed. In this second scenario the real occupancy and equipment load are considered. Primary energy is the sum of consumption of the entire building.

- Design

Precise indications about the type of renovation admitted for buildings of historical and architectural interest are given the article n. 25 of the Urban Building Regulation Code. In particular the interventions can be:

– the renovation of the architectural features and the restoring of altered parts: renovation of outer facades or interiors, philological re-construction of eventually missing parts of the building, conservation or restoring of shared spaces like courtyards and gardens;

– the consolidation with substitution of un-repairable parts without modifying the position and height of major walls, lofts, ceilings, stairs and roofs (with re-making of the original roof covering;

- the removing of elements that have been recently added or are incoherent with the original scheme of the building;
- the insertion of essential technological and sanitary installations, respecting the previously given constraints.

The building is qualified as building of historical and architectonic interest in the Urban Building Regulation Code, and therefore admits only respectful interventions of renovation and maintenance. The typologies of intervention and modification admitted are described at the art. n. 57 of the Building Regulation Code, specifically with requisites nr. IS 1, 2, 3. In particular, the Regulation Code prescripts to preserve the original integrity of every architectonic, artistic and decorative elements of it.

For the preservation of original characters of the building, the limitations, given by the requisite ARE nr. 1 of the Code, are the following ones:

- to preserve and conserve the building roof in its original shape and consistence, and this concerns specifically interventions like the insertion or addition of chimneys, skylights, gutters or pluvial; in particular, in the conservation of the original shape of the roof, every new component put in substitution must have the shape and colour of the previous original one;
- roof insulation and ventilation must be extended to the whole roof surface, keeping the thickness inferior to 20 cm, eventually rising the roof's height;
- to insert small chimneys for airing in order to conserve the original shape of the roof, putting them close as possible to the

roof top, avoiding products made of cement, fibre – cement, or plastic;

- to keep the technological installations for the reception of signals (like parabolic antennas for TV/Earth satellite signals) within the number of one for building, placing them inside indoor locations or on secondary pitches;
- to satisfy the need for lighting of every indoor room, avoiding the opening of slots in the roof pitches, using only skylights, keeping these aligned to the existing ones, at a distance of at least 1,5 m from the gutter's line;
- to keep the gutters and the pluvial in good conditions: in case of substitution, products made of plastic or zinc laminate must be avoided;
- To keep the original shape and design of every facade: this concerns specifically the opening of new windows or the changing of the dimensions of the existing ones, the making of terraces, balconies, bow-windows or facade chimneys which is avoided for all the facades facing external public spaces. Only the re-opening of previous existing windows is permitted. Modifying existing openings is allowed only if the facade overlooks minor patios or backing spaces and if it collaborates to the rational reordering of the facade image.
- The impact on the facade of the positioning of electrical wirings must be reduced as far as possible; the wires and the installations components must be hidden in every possible way, as far as the norms on safety allow it, by locating them inside the building or under the paving of the street or the one of the porch, When on

main facades, they should be aligned and positioned in order not to interfere with decoration or painted parts. It is avoided to install heat pumps, boilers, air conditioners, or motor condensing units on roof pitches, on main facades and under porches.

- To extend the maintenance of original plasters and superficial coatings to every coated facade of the building, in order to preserve them as they were.
- To keep the original window infixes and shading elements in every external perimeter wall. In case of substitution, which is admitted only if the original components cannot be repaired, the new inserted elements must have the same partition, material, colour and shape of the previous.

Then, for the preservation of the historical characters and of the original indoor distribution scheme of the building, the constraint, expressed by the requisite IS n.2 of the Code, prescript to maintain the original status; in particular:

- adding new dividing surfaces is allowed only if they do not interfere with the facade's openings;
- original dividing walls, even the secondary ones with no structural function, with architectural value or original decorations, original garrets or suspended ceilings with historical value must be maintained and renewed;
- New lofts located inside the rooms must be fixed to the opposite wall facing the external one with windows and openings, at a distance of at least 2,40;

- The whole area of the new single rooms located inside the historic building can't exceed the 30% of the whole area of the building;
- New rooms can be located in the under-roof space only in case the electrical installations and wiring needed do not interfere with existing elements of architectural and historical value.

The constraint for the preservation of external and open spaces of historical buildings, given by the requisite IS n.3, prescripts to keep the original organization and conditions of gardens and courtyards. Therefore:

- The installation of service lifts, anti-fire stairs or elevators, which cannot be done by means of enclosed volumes, is permitted only in minor courtyards and patios, on minor architectural value facades, positioning them outside of the optic cone of the inner major rooms or entry porches.
- The ecological balance of gardens cannot be altered.
- Original garden pavements and furniture must be maintained in the original conditions.

In some part of building, walls are covered by frescos or there are possibilities to find them below the painting layer. In figure 58 are presented in red areas where there is already restored frescos and in blue areas that are abject of intervention in this restoration. For information about thickness and technical data of material is possible to see some measure from plan on the following figure.

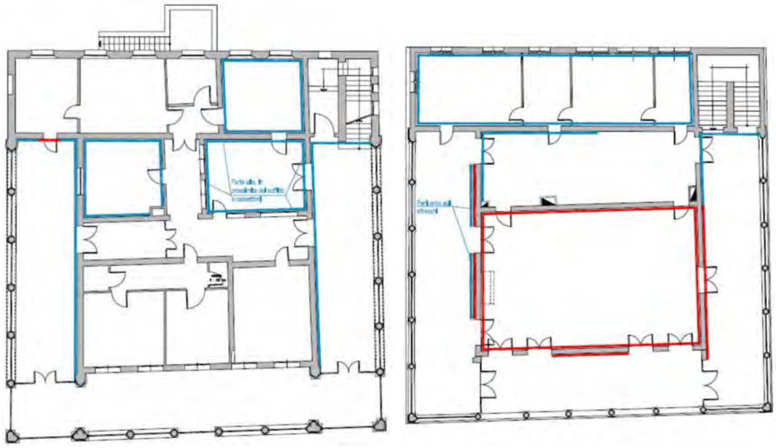

Figure 58_ Plan of frescos in Building

Some internal partition will be removed respecting the constrain condition imposed by the Authority of Cultural Heritage. The plan in figure 59 shows these partition in yellow.

Figure 59_Plan of demolition at ground and underground floor of partition wall

- Windows

It is necessary to respect colours, size and shapes of the windows; to keep the original shape and design of every facade: this concerns specifically the opening of new windows or the changing of the dimensions of the existing ones, the making of terraces, balconies, bow-windows or facade chimneys which is avoided for all the facades facing external public spaces. Only the re-opening of previous existing windows is permitted. Modifying existing openings is allowed only if the facade overlooks minor patios or backing spaces and if it collaborates to the rational reordering of the facade image.

Keeping the original window's infixes and shading elements in every external perimeter wall is necessary. In case of substitution, which is admitted only if the original components cannot be repaired, the new inserted elements must have the same partition, material, colour and shape of the previous.

Windows will be restructured so it is possible to think to change something as glass or shielding that could respect the limitation.

- Roof

To preserve and conserve the building roof in its original shape and consistence, and this concerns specifically interventions like the insertion or addition of chimneys, skylights, gutters or pluvial; in particular, in the conservation of the original shape of the roof, every new component put in substitution must have the shape and colour of the previous original one.

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the European Union

Roof insulation and ventilation must be extended to the whole roof surface, keeping the thickness inferior to 20 cm, eventually rising the roof's height.

To insert small chimneys for airing in order to conserve the original shape of the roof, putting them close as possible to the roof top, avoiding products made of cement, fibre – cement, or plastic.

To keep the technological installations for the reception of signals (like parabolic antennas for TV/Earth satellite signals) within the number of one for building, placing them inside indoor locations or on secondary pitches.

To satisfy the need for lighting of every indoor room, avoiding the opening of slots in the roof pitches, using only skylights, keeping these aligned to the existing ones, at a distance of at least 1,5 m from the gutter's line.

- Systems

All the systems were removed so there is space for good intervention. It is possible to reuse distribution scheme of old system and open some new hole preserving as much as possible the walls.

It is possible to use space around building as technical space to place some technical system like generator.

vi. Implementation

The refurbishment of Palazzina della Viola consider structural consolidation, preservation of frescos and artworks and the modernization of the facilities.

Main constrain for energy efficiency improvement is the interdiction on changing the windows along the galleries. The only action that took place on them was the installation of solar protection film. The other windows have been restored and double glass pane has been installed.

Most of the floors have been rebuilt after the consolidation of the foundation and one impermeable layer has been added.

All the systems have been substituted with VRF direct expansion heat pump assisted from ventilation system for the control of the air quality. This technology provided heating and cooling with a reduced impact of the distribution network on the building.

The pipes were installed behind a plasterboard panel along the walls in the galleries and in the floor structure where it has been rebuild. The ventilation system has been installed in the attic, no heated area dedicated to the VAV system with the heat recovery. Extensive use of led technology has been used for the reduction of electric energy consumption.

vii. Post Evaluation

Status of the building at the end of the refurbishment works.

Figure 60_ Main facade after refurbishment work

Ground floor:

Figure 61_Images of the ground floor after refurbishment

First floor

Figure 62_First floor after refurbishment

viii. Short description of building

Singular light masonry building, defined as a “jewel of the Renaissance art”.

This isolated building, built in 1497 as little hunting hut, has a quadrangular plan (4 floors,300 m2 per floor, around 4240 m3 of total volume), with three glazed facades (partly plastered) lightened by a double open gallery.

The structure is load bearing masonry walls and ceilings made of steel beams and brick elements. This listed building is enriched at the ground and 1st floor, by frescoes and painted wooden ceilings

(15th and 16th C.), attributed to Amico Aspertini and Prospero Fontana.

The building was the College for the University of Bologna students who came from Piedmont (a northern region of Italy) from 1540 to 1797; in 1803 it was acquired together with the land plot around it by the Government of the Italian Republic to host the Faculty of Agriculture and the Botanical Garden. The building has been object of rehabilitation intervention at the beginning of 1900. After WWII, the N-W corner of the building was rebuilt because destroyed by a bombardment. Several other partial remakes date from the last 60-70 years. Rehabilitation preservation interventions and functional requalification has been started at the end of 2010.

One of the added value context remains on the fact this building presents a different architectural style from the others buildings of the same quarter (mainly from 1900). The building is socially representative as presents walls and ceilings decorated or painted at frescoes.

ix. Overall conservation status

Conservation aspects: The building is located in the "Comparto Filippo Re" of Bologna between the old city walls and the Botanic Garden. The site is characterized by the presence of other historic buildings (mainly from 1900) connected by pedestrian paths and parking for university staff. Buildings are surrounded by green areas with trees.

Conservation aspects: a XV century building defined a "jewel of the Renaissance art", characterized by three glazed facades and located just outside the gates of the old city walls. The architectural style of the Palazzina della Viola is completely different from the others buildings of the same quarter.

x. Evaluation of the construction´s situation

The procedure employed to perform a comprehensive diagnosis of this historical building has been repeated after the refurbishment works. In addition to the information recovered by the climatic WSN monitoring described in the previous chapter, several non-destructive techniques such as IRthermography have been applied (Figure 63) in order to evaluate the current health-state of the Palazzina. Moreover, some "movable" WSN node have been used for innovative dynamic environmental focused monitoring. Results of distribution maps of light, air temperature, relative humidity, at various levels from ground, are useful for evaluating risk to CH and level of protection needed for delicate artefacts, as well as discomfort of working conditions.

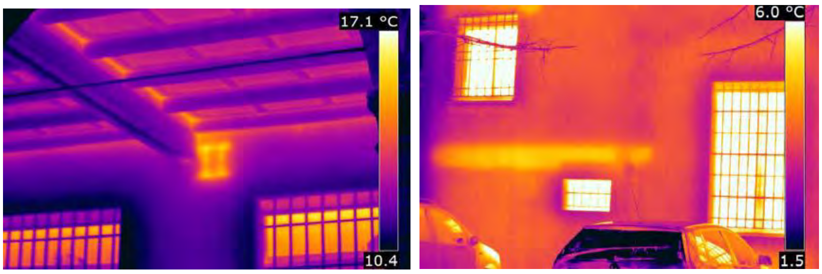

Figure 63_ Post-refurbishment NDT of thermal bridges by IR thermography: steel beam-ends (left); concrete stairs landing (right).

d. URBAN CONTEXT

i. General description

The building is located in the "Comparto Filippo Re" of Bologna between the old city walls and the Botanic Garden. The site is characterized by the presence of other historic buildings (mainly from 1900) connected by pedestrian paths and parking for university staff. Buildings are surrounded by green areas with trees.

ii. Analytic description

The Palazzina della Viola was built in 1497 by Giovanni II Bentivoglio at the city boundaries for his son Annibale as hunting hut and place of delight. It owes its name to the violets blooming in the meadows. In 1505, after an earthquake, the Bentivoglio family took refuge in the building and one year after it was plundered by Bentivoglio enemies. After the Annibale's death, in 1540, the building was sold to the Felicini family and used before as Literary Academy of "Viridario" and after as Academy of "Desti".

Few years later, the Cardinale Bonifacio Ferrerio bought it and the Palazzina became a student residence since 1797 where it was expropriated during the Napoleonic era. Actually, the 17th C. was a period of negligence for the Palazzina since the building was abandoned several times and some bad interventions were done in the middle of 17th C: the loggia at the 1st floor was closed to obtain rooms, some frescoes were covered with plaster or tapestry and others frescoes were damaged.

In 1803 the building passes to the Italian Government and later it becomes the Headquarters of the Agriculture Faculty and Botanical Gardens.
In 1907 the "Cassa di Risparmio" of Bologna financed the renovation: the loggia at the 1st floor was reopened by demolish the non-load bearing walls and the frescoes behind the plaster were recovered. Minor interventions were also done in 1928.

After the WWII long refurbishment works were done to repair the damages caused by the bombing of June, 22, 1944. In detail, the N-E side was rebuilt, the porch on the main facade and the superior loggia were recomposed and restored and the damaged walls were repaired. Later on the frescos were also restored.

e. Local Climate Data

i. General description

Temperate climate

ii. Analytic description

- Climatic Zone E
- 2.259 Degree days
- Heating day per year: 183.
- Winter temperatures (medie) -5°C
- Summer temperatures 33/22°C
- Winter HR max: 95%
- Summer HR max: 43%

- Average wind speed: 1,60 m/s (max 3,20).
- Prevailing wind direction: South/West.
- Altitude: 54 m.
- Coordinates: Lat. N 44° 29 ‘ - Long. E 11° 20’.

f. ENERGY DEMAND

i. Building Energy performance

The energy needs of winter heating and summer of a building depends on several factors: the climate, the architectural characteristics and thermal envelope, the type of heating system, the free contributions (solar and internal) as well as parameters such as very unpredictable behavior related to the occupant’s activities.

ii. Building Services (as-is-state)

- Heating System

The heating system used in the past consisted in a gas-oil boiler (THERMITAL TH-NG 200) that was located in the underground floor. Different kind of radiator are present, some of them are hidden into the ceilings but the majority was placed below windows. Some vents related to AHU no longer present are located in the large room at the first floor. The distribution system is made of iron and copper pipes. The oldest pipes have a layer of canopy and lime.

- Electrical System

Electric installations were almost completely removed. No technical information is available.

- Ventilation System

A ventilation system was used as heating system in the first floor. It is not sure if the system was or not used also for ventilation, treated air, night ventilation. No information is available and the type of control is unknown.

- Use of Daylight

Openings in the roof. In some rooms, both at the ground floor and first floor, there are no windows; daylight comes from glazed doors.

2 GENERAL OBJECTIVES

a) Proper integration of the building in the surrounding
b) Preservation of architectural elements
c) Comfort and well-being inside the building
d) Maximum reduction of the environmental impact, and the use of raw materials;
e) Integration between new technological improvements and the existing building.

3 GENERAL STRATEGIES

a) Careful analysis of the building before the intervention
b) Control of the incident radiation on transparent surfaces of the building during the summer by the use of solar shading systems

4 REFERENCE

The source for this study case is the EU project 3encult - Efficient energy for EU cultural heritage, accessible on http://www.3encult.eu/en/casestudies/default.html#CS03.

3encult was co-funded by the European Union Seventh Framework Programme (FP7/2007-2013) under GA nb. 260162.

EH-CMap
Advanced Training on Energy Efficiency in Historic Heritage

CASE STUDIES DATA SHEET

CINETEATRO LOULETANO

0 KEY WORDS

Municipal Heritage

Multicultural space

Sound insulation

Lighting systems

HVAC system

Photovoltaics sources

Co-funded by the European Union

1 Type Of Interventions

a. General Information

i. Location

Loulé, Algarve, Portugal.
Avenida José da Costa Mealha
8100-501, Loulé
GPS: 37.138913, -8.02246

Figure 1_ Territorial framework

i. Regulation Constraints

In the regulation of Loulé Municipal Master Plan is referred the classification of Cineteatro as property of municipal interest.

The article nº 43 of the Law nº 107/2001 determines the legal protection of the surrounding area and restricts constructions and demolitions on the perimeter of 50 meters of the building.

i. Protection/Conservation status/level

The work was done in compatibility with the guidelines provided by national laws and the architectural project. Today the building is in good conditions due to the restoration operations and maintenance.

The constantly conservation of the building is done by:

- A technical manager of the building which coordinates all maintenance activities;
- A weekly checklist to control all tasks to maintain the proper functioning of the building;
- Videos provided by installers of equipment (HVAC, fire pumps, mechanical of scenography, etc.) to supervise the technical backgrounds.

However, there are two zones where the conservation status is very difficult to maintain: stage and auditorium. In both, the floors are in wood which obliges the constant maintenance of the superficies (paint and varnishing).

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b. General Description _ Before Restoration

i. Date of construction

1925-1930

ii. Architect

João Baptista Mendes

Figure 2_ Historical picture of Teatro Avenida (Cineteatro Louletano) integrated in the urban area.

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iii. Architectural style/styles

Architecture of 30s of XX century.

iv. Construction phases

Phase 1: Original construction 1925-1930

Phase 2: Remodelling work 1999-2001 (roof rupture, stage, auditorium and walls with infiltrations)

Phase 3: Restoration work 2008-2010

v. Original use

Theatre and cinema events

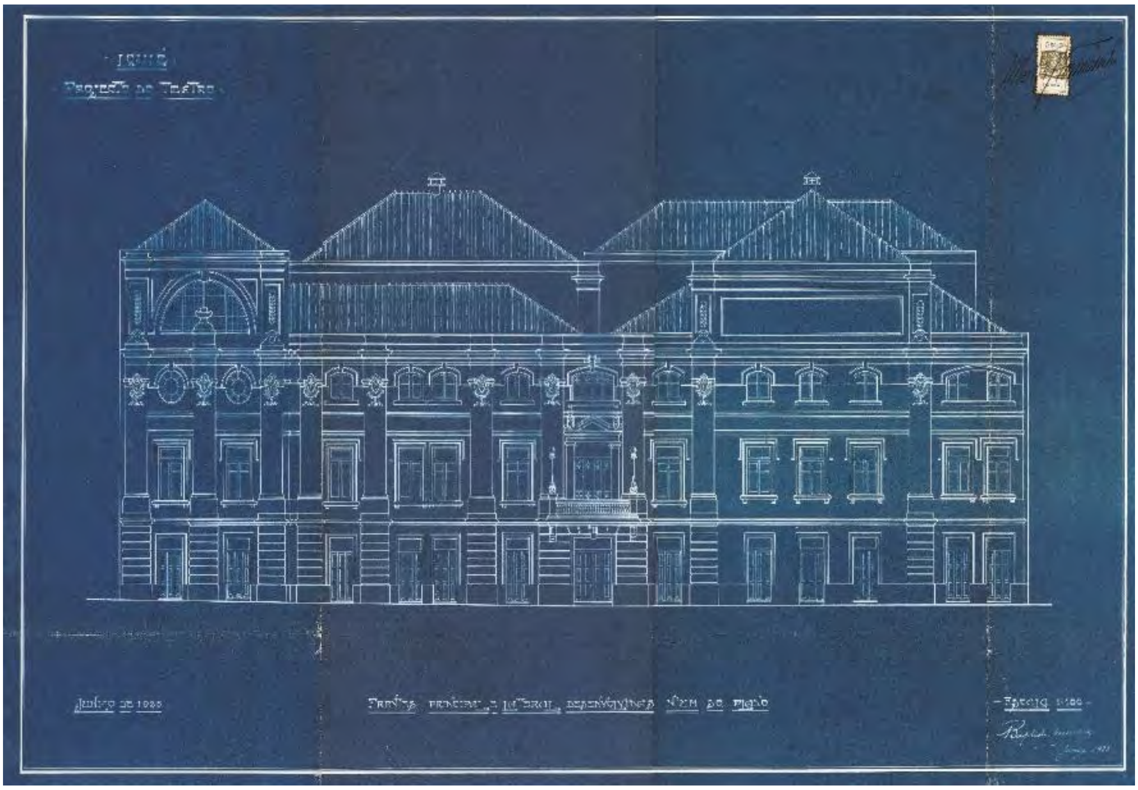

Figure 3_ Original project excerpt (1925): building's facade.

Figure 4_ Picture of inauguration day, 1930.

Figure 5_ Interior of auditorium before restoration.

Figure 6_ Interior of auditorium before restoration.

Figure 7_ Aerial view of the state of Cineteatro Louletano before restoration work

vi. Construction materials

Due to financial restrictions the building was built in various phases, where was used diversified materials and methods.

The main materials used were:

- Indoor
  - Walls: stone masonry and lime based mortars. Walls of corridors covered with carpet and wood as an ornamental decoration;
  - Upper Floors: beams and slabs reinforced concrete;
  - Ceiling: mortar with wooden slatted;
  - Stage: structure and wood flooring;
- Outside
  - The pitched roofs were performed using implemented metal structures with wooden elements. Coverage with Portuguese tile;
  - Facades: ornamented by cement and stone. Some parts are false ornamentations which reproduce stonemasonry techniques. However, some parts of the building presents stonemasonry in stone, like, in pillars, doors and windows outline, cornices and cornices, punches, etc.

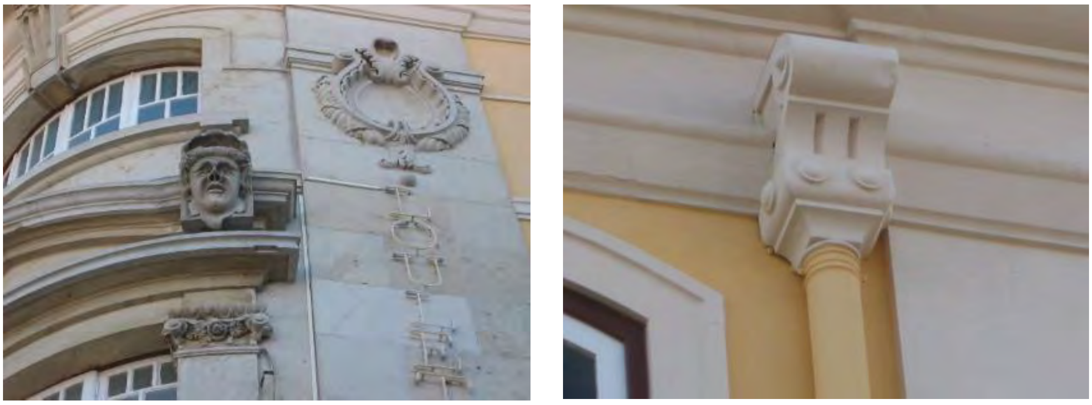

Figure 8_ Some decorative elements of the facade.

vii. Construction method

Remark: It was not possible access the documentation of construction methods. For this reason, this topic is not complete.

- Covering systems:

The structure of ceiling was made with wooden slatted and mortar. The pitched roofs were performed using implemented metal structures with wooden elements. Coverage with Portuguese tile.

- Reinforced concreted systems:

Columns and beams structural were made with reinforced concrete with the irons bent and linked to brackets. The connection between the concrete structure and masonry was done by the support beams.

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- Stonemasonry system:

Structural function of the whole building, was applied the carved stone in the most important areas of the building: pillars, door openings contour and windows, cornices and cornices, punches, etc.

- Stage:

The stage was built considering the "Italian stage" style, structured by wooden slatted and stage floor covered by wood.

The main wall of the stage was constructed by reinforced concrete directly bound to a wall of neighbor building [regarding this issue, please see the point c. vi: Construction method – Insulation].

c. General Description _After Restoration

i. Date of restoration

2008

ii. Architect

Luís Durão - JA ARQUITECTOS, Lda.

iii. Typology of building

Multipurpose space for cultural events with 6 floors levels and 1 underground floor (below the stage: -1 floor). The space is organized by an auditorium with an audience pit, two upper balconies, stage, and a highest floor where stands the "Web" (5^{th} floor).

iv. Present use

Multipurpose space for cultural events

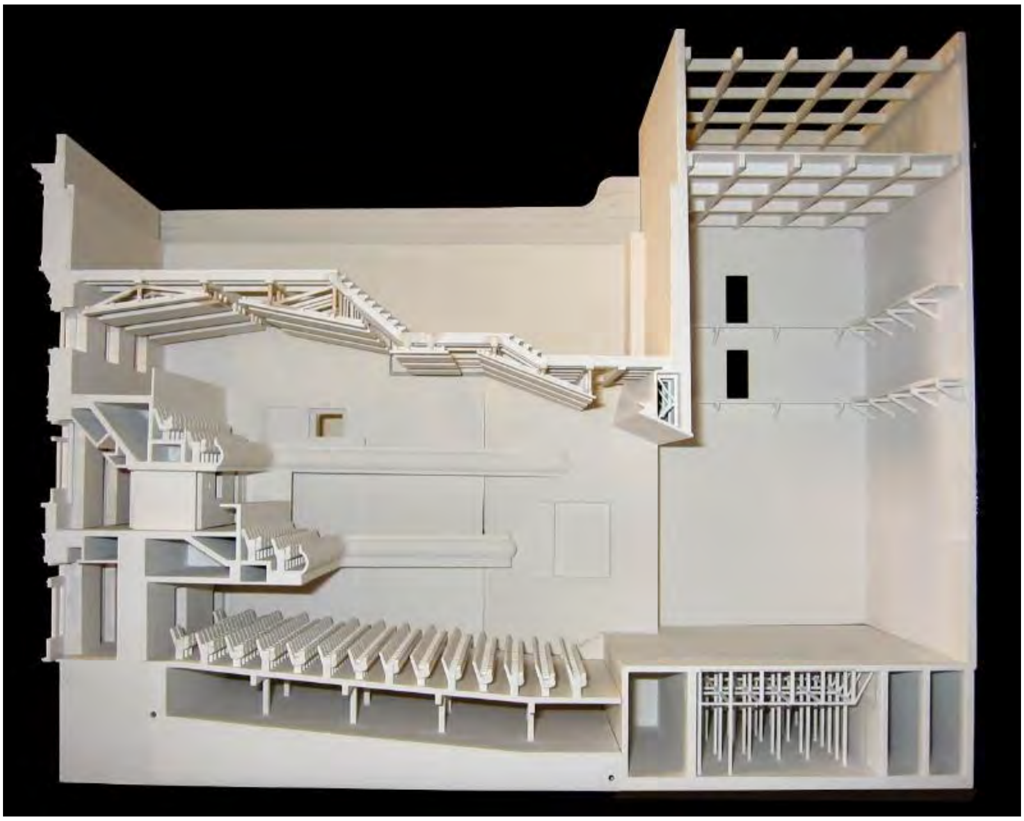

Figure 9_ Architectural mockup of the restoration project

iv. Restoration purpose

To preserve the image of Cineteatro Louletano giving it better conditions for a more multipurpose space, safe, comfortable and able to receive shows with high levels of exigency. The restoration project aimed recovering the building, restoring its functional capabilities and interior rooms repair and renovation of the elements and composition structures, elevations and coverage.

At the security level, were created new evacuation routes in accordance with the rules in force, and the indications of security expertise from fire hazards, fulfilling with recommendations of the National Fire Service, Civil Protection and IGAC - General Inspection of Cultural Activities.
Considering that was a big and important restoration work, here will be underlined the various restoration options to create a more functional building.

Were demolished several structures and building elements:

- Stage box, sub-stage, dressing rooms and backstage. Was preserved the facade facing the Avenue José da Costa Mealha;
- Tile coverage of the auditorium, the entire exterior coating, structure, plaster ceilings, friezes, lamps and interior cladding. Remained the chimney/skylight with pinwheel, and the lamps were restored and reapplied;
- Demolition of all interior stairs;
- Destruction of dais and false pavement of the audience and of 1st and 2nd balconies. Preservation of pre-existing reinforced concrete structure;
- Total demolition of the 3rd balcony. However, were preserved the main auditorium structures, the audience, 1st and 2nd balcony, and the room was recovered for a capacity of 325 spectators (230 audience seats [+4 handicapped]; 46 seats on the 1st Balcony, and 49 seats on the 2nd Balcony).
- Demolition of lateral friezes of proscenium;

- Demolition of several walls sections and exterior and interior slabs;
- Demolition and drilling to openings for water systems, sewers, electricity, telecommunications, mechanical, air conditioning, security, ventilation and smoke extraction.

v. Construction materials

All materials used in restoration work obeyed the regulations into force the Portuguese Standards, the Approval Specifications Documents of LNEC[1] or into force in the EEC[2].

- Steel Structures

The lobby has a stair structured by metal, based on the ground floor, connecting to the upper floor (the bar).

In all the Cineteatro were added technical metal walkways (stage and audience). In the audience the metal walkways are structures supporting the ceilings, lighting and sound equipment. The new room (auditorium) has three roofing metal structures. The stage and auditorium were covered by a slab that is supported by metal beams.

All metal elements have adequate corrosion protection.

[1] Laboratório Nacional de Engenharia Civil (National Civil Engineering Laboratory).
[2] European Economic Community.

- Walls structures

Some indoor walls were structured by reinforced concrete and metal profiles, to ensure consolidation of facades, by applying innovative techniques and seismic resistance current standards.

- Mortars laying

Ordinary Portland Cement (OPC) and sand in the stonework settlement of brick and cement, and in the freestone settlement. Settling of concrete blocks with mortar.

- Indoor walls

Plastering of Mortar of Ordinary Portland Cement and sand. In some areas, the walls are painted with stucco or covered with wood and plaster, and with ceramic materials (e.g. toilets).

- Interior partitions

Brick walls, panels and plasterboard or plywood boards (acoustic and thermally insulated), metal frames and tempered and laminated glass panels.

- Accessibility system

The floors were connected by vertical columns of accesses, made by stairs and elevators, for public and internal services access.

- Flooring

Made of cement and coated by wood and carpet for damping percussion noises (auditorium). The vertical access and circulation areas and foyers are coated with stony, metallic and synthetic materials.

- Stage

The stage structure was covered by a slab which is supported by metal beams. The stage floor was covered by wood properly treated and varnished.

- Ceiling

Stucco ceilings with acoustic characteristics, with acoustic bandwidth KNAUF/ 30mm, neoprene, between the U profiles of galvanized steel. All metal elements fixing and/or suspension ceiling are of stainless materials and have corrosion protection.

- Thermo-acoustic insulation system

Thermo-acoustic insulation constituted by semi-rigid plates, of rock wool fibers with density of 70 kg/ m3, bonded with synthetic thermo-hardened resin with a uniform thickness of 50mm, and a face coated with a veil anti-disintegration of black natural fiber (type ROCTERM).

- Roof

Covered by Portuguese tiles (named “telha de canudo”) and corrugated plates. The plates are fixed by screws isolated to cover slabs of reinforced concrete and on thermal insulation.

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- Indoor ornaments

Paste of lime mortar and fine white sand.

vi. Construction method

- Steel Structures

The lobby has a stair structured by metal, based on the ground floor, connecting to the upper floor (square profile 250x250x12). In 3 floors (entrance lobby, bar and bar coverage) remained part of the existing floor slab (to balance the original walls have been preserved). The new slabs as total height of 15 cm and a thickness of 1 mm. These slabs support the new metallic structure of the atrium and bar.

On the technical metal walkways (stage and the audience) were used simple metal profiles (H, UPN, IPE, IPN). The main beams (UPN and H) of the audience walkways were embedded on the existing walls and locked by IPE profiles. In the audience the metal walkways also serve as support for the structuring of ceilings and lighting and sound equipment.

The new room (auditorium) has three roofing metal structures. The stage is covered by a slab that is supported by metal beams H fought by IPE profiles.

Figure 10_Application of metal stairs from lobby to upper floor (bar).

- Walls structures

Some indoor walls were structured by reinforced concrete and metal profiles, to ensure consolidation of facades, by applying innovative techniques and seismic resistance current standards.

The masonry of 4th floor were built by brick plan 30x20x22.

The double walls were built by a brick plan 30x20x11 and 30x20x15.

- Mortars laying

Ordinary Portland Cement (OPC) and sand in the stonework settlement of brick and concrete, and in the freestone settlement. Settling of concrete blocks with mortar.

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- Indoor walls

Plastering of Mortar of Ordinary Portland Cement and sand. In some areas, the walls are painted with stucco or covered with wood and plaster, and with ceramic materials (e.g. toilets).

- Interior partitions

Brick walls, panels and plasterboard or plywood boards (acoustic and thermally insulated), metal frames and tempered and laminated glass panels.

- Flooring

The floor of auditorium is coated by wood and carpet for damping percussion noises. The vertical access and circulation areas and foyers are coated with stony, metallic and synthetic materials.

- Sub-stage and stage

Increasing the level of sub-stage (-3.55m) allowing an acceptable working height for the stage technicians. The stage received a steel structure, covered by a slab which is supported by metal beams. The stage floor was covered by wooden slats properly treated and varnished. The stage floor was divided for the opening of trapdoors, which allows the direct connection between stage and sub-stage.

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Figure 11_ Assembly phase of the new stage

- Ceiling

The under-coverage of the auditorium was made with "Sandwich" panels and stucco ceilings with acoustic bandwidth KNAUF/ 30mm, neoprene, between the U profiles of galvanized steel. All metal elements fixing and/or suspension ceiling are of stainless materials and have corrosion protection.

- Roof

Tiles are supported by corrugated plates type "Onduline" and panel "ondutherm sandwish" h19 + a60 + h10. The plates are fixed by screws isolated to cover slabs of reinforced concrete and on thermal insulation.

The tiles were attached to the corrugated plates with cement mortar, lime and sand only at the rear. The tiles that finish with masonry or concrete surfaces and finished with the spike or roof ridge were applied with mortar.

On the roof of the auditorium were applied Portuguese tiles “telha de canudo”, placed under PVC ripped, through stainless steel staples.

Figure 12_ Roof structure

- Waterproofing terraces

Waterproofing system consisting of two crossed screens polymer bitumen with APP 4KG/m2 each, protected polyethylene, polyester-reinforced armor 150g/m2, type "POLIYXIS R40 C", placed on two coats of emulsion bituminous type "F IMPERKOTE".

- Insulation

Thermal acoustic insulation on the backrest of the new building (auditorium and stage) to the adjacent buildings, consisting of the application of extruded polystyrene plates. The panels filled the joint south elevation between the two buildings.

- Indoor ornaments

- Painting System

  The paintings give to the surfaces the ability to withstand the mechanical aggressiveness, environmental, chemical, biological, fire, etc., and improve their cleaning possibilities and aesthetics.

- Outdoor ornaments

Stone cladding applied in the north elevation, similar to existing, 20 mm thick with a smooth finish and glued to the masonry.

- Stonemasonry system

  The stonemasonry that were degraded with pollution and other atmospheric agents, were treated and or were added new masonry using the same type of stone.

vii. Short description of building

Cineteatro Louletano is a good example of Portuguese Modernist Architecture of XX century, and its construction gives it interesting features.

After five years of construction, “Teatro Avenida” (the first name of Cineteatro Louletano) was inaugurated in 1930 as an important place for cultural life of Loulé city.

It is considered the first building of the Algarve where it was used the reinforced concrete as a modern engineering technique.

Is also an example of simplistic architecture which announces the using of modern materials (like glass, iron and cement) and applied simple architectural ornamentations.

The building is placed on the corner of two streets – Avenue José Costa Mealha (North) and Street Dr. Frutuoso da Silva (West) – uncommon for a theatre. Because of this characteristic, in Portuguese is defined as “teatro em gaveto” meaning its position in a corner.

The outside and the overall volumetric of the building, denounces that stage box rises above the cyma of the building, delimited by a cornice. This characteristic highlights the presence of Cineteatro at urban area but also strengthens its architectural originality.

In 2003 the Municipality of Loulé acquired the building in order to preserve the main cultural building of the city.

After years of restoration works, in 2011 Cineteatro Louletano was inaugurated with better conditions to receive various cultural shows, being more accessible for any target public, and to be distinguished as one of the best cultural auditoriums of the Algarve region.

viii. Overall conservation status

The current general state of preservation is good thanks to the remediation of the building structures (stage, auditorium, stairs, and public spaces - bar, toilettes, dressing rooms, etc.). Taking advantage of the pre-existing conditions, the intervention aimed to give better conditions for cultural events and be an accessible building for any target public. Also, in the restoration project were considered energy savings and building's security, with the implementation of new technologies and improvement of interior access.

ix. Actual European Energy Standard

European legislation on energy efficiency in historic buildings does not require compliance with minimum standards and grants the power of decision to the member countries. Thus, the legislation to any intervention on the heritage varies between EU member states.

In Portugal the national regulations exclude monuments and buildings individually classified or to be classified those that are recognized special architectural and historical value and buildings integrated in sets or classified sites or to be classified, or located within protection zones (DL 118/2013).

d. Urban Context

i. General description

Cineteatro Louletano is located within the city of Loulé and was inaugurated in 1930 the twentieth century. In 1918 the city of Loulé achieved the highest urban work, the opening of the Avenue José da Costa Mealha, where the bourgeoisie built some of the finest examples of civil architecture of this century.

Until the implementation of Estado Novo (New State) were held some important works for the modernization of the urban space, of which stands out the electric lighting in 1916, replacing the oil lighting, and the beginning of the public water supply to the urban center of the village.

Between the years 1926 to 1974, Loulé grew moderately: cross streets of Avenue José da Costa Mealha were urbanized and the current Avenue 25 de Abril was opened.

During this long period, the most significant public buildings were the Cineteatro Louletano of the Architect João Baptista Mendes, and the Monument to the Engineer Duarte Pacheco designed by the Architect Cristino da Silva.

In recent years there has been an accelerated construction in Loulé. To the northeast, east and south of the Avenue José da Costa Mealha huge collective housing buildings have been occupying old farms and traditional architecture buildings.

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ii. Analytic description

1) From the Prehistory to the Middle Ages:

Archaeological remains confirm that the human presence in Loulé municipality dates back to the Palaeolithic.

In the period of the Age of Metals, the Phoenicians and the Carthaginians reach the Iberian Peninsula, founding the first trading posts on the waterfront of the municipality of Loulé, developing the fishing industry, metallurgy and commercial activity.

The Romans developed several coastal fishing sites and fish salting, having Loulé Municipality the most known archaeological roman site "Cerro da Vila". Also the Romans occupied the lands near the area where the medieval castle of Loulé was erected.

With the arrival of the Muslims, in the eighteen century was born the medieval town which generates the current historic city.

During VIII-XIII centuries, Loulé was an important urban centre named Al’-Ulyã. The 9th-10th centuries were epochs of political and military instability in the Islamic world, with internal dissensions which were reflected throughout the Garb Andaluz, leading the construction of several military buildings. Probably the Al-'Ulya' (Loulé) was fortified during this period.

The Christian reconquest, in 1249, and the policy of maintaining the Muslim population on Algarve (even though

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living in extramural neighbourhoods, the “mourarias”), allowed Loulé’s developing.

In 1291, the King D. Dinis ordered the creation a fair in Loulé village, during fifteen days in September, to highlight the economic potentiality of agricultural (mainly almonds and figs) and the handicraft local products. Thanks to this initiative, the village was one of the biggest commercial centres of medieval Algarve.

The Portuguese expansion (began in 1415) gave to the Algarve region a new phase of economic growth, and Loulé was distinguished by the export of wine, olive oil, dried fruits, handicrafts, salt and fish. This economic prosperity made it possible to recover public spaces and to construct new buildings in the village.

2) From Modern Age to the 20th century:

From 1620, the economic vigour of the Algarve begins to decline, the population stagnates and the political instability persists, which also affects the urban expansion of Loulé. However, was a period where several religious buildings were constructed (e.g.: Church Portas do Céu, the Chapels of Nossa Senhora da Conceição, Nossa Senhora do Pilar and Nossa Senhora do Carmo, and the Church Espírito Santo).

After the Restoration of Independence (1640) the Loulé Castle gradually loses its defensive value, although the areas addorsed the ramparts continue to develop new constructions.

The 1755 earthquake significantly destroyed the urban center. The towers of the castle were broken and the ramparts collapsed.

After the reconstruction of the town, arise in various urban areas, manors belonging to the local bourgeoisie. In the beginning of 19th century, policy instability provokes a new economic crisis and, subsequently decreases the urban and architectural development of the town.

The statesman, juris consult and political Mouzinho da Silveira, decreed the sale of national goods and the expropriation of the Church properties. The national reforms were also implemented in Loulé with the closure of Monastery Espírito Santo, in 1836, occupied by Municipal Chamber and Judicial Court, the convent church was deactivate and transformed in Theatre, and the annexed areas of castle ramparts were divided land into lots and occupied for residential and commercial purposes.

Till the final of 19th century Loulé expanded to west, and had a demographic increase associated to the phenomenon of industrialization which attracted the population for the factories established in the council.

Before the 1st Republic, the Municipal Market was built (1904-1907) by the architect Mota Gomes, as one of the most important buildings of the city. This project considerably changed the urban design of the central area of the village, provoking the demolition of castle ramparts and of some significant buildings.

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In 1918 was open the Avenue José da Costa Mealha considered a biggest urban change, and where the rich bourgeoisie built good examples of civil architecture of the 20th century. Several urban works were done during this century in order to modernize the city and its access.

Cineteatro Louletano was one of the buildings built in the first half of the 20th century, edified on Avenue José da Costa Mealha and inaugurated on 19^{th} April 1930. Throughout the entire 20^{th} century was the principal multipurpose auditorium of the city, serving for theatre and cinema events.

e. Local Climate Data

i. General description

The climate is warm and temperate.

ii. Analytic description

1) Average temperature of 16.4 ° C
2) Average annual rainfall of 544 mm
3) Winter temperatures (media) 10.8 °C
4) Summer temperatures (media) 22.9 °C

f. Energy Demand

i. Energy performance of the building

Have been equated all aspects related to energy consumption, management and maintenance of the technical infrastructures, in the sense to control and optimize any waste, and irregular use of the spaces of the Theatre.

The restoration project was drawn up before national energy efficiency legislation. The only legal reference in the project on this matter was the Decree-Law nb. 80/2006, of April 4 on RCCTE - Regulation Characteristics of Thermal Performance of Buildings. This Decree-Law was repealed with the entry into force of Decree-Law nb. 118/2013, of August 20 on System Energy Certification of Buildings (SCE), on Regulation of Energy Performance of Residential Buildings (REH), and the Regulation of Energy Performance of Buildings Trade and Services (RECS). This new legislation is posterior to building's construction.

ii. Passive measures

- **Lighting**

The building is equipped with various types of lighting:

1) Natural Lighting:

   Allows lighting the atrium, corridor leading to the auditorium, offices, dressing rooms and stairs;

2) Artificial Lighting:

   Fluorescent lamps and compact fluorescent lamps, which illuminate certain sites of theatre;

3) Emergency Lighting:

   Mandatory in any public building for in case of evacuation of the building. The lamps are connected to a power source which also enables centralized management and identification of faults. This source is equipped with lead batteries easily accessible for maintenance, being an effective and environmentally sustainable solution.

4) Auditorium Lighting:

The control of room lighting is normally controlled by the technical team which manages the show, taking in account the established scenario and typology of the show. For this function are used the equipment of dimmers type, which allows the gradual alteration of light intensity respecting the pre-established temporizing.

5) Scenic Lighting:

Is the illumination of the show. It is composed of various types of projectors, optics and different colours, and robots. The stage lighting is controlled through a control desk. The stage lighting is highly specialized.

- **HVAC system**

The interior environment is controlled from the HVAC technology (heating, ventilation, and air conditioning).

HVAC is composted by four fundamental elements:

1) Chiller: Unit which produces heat and/or cold for RTUs;
2) RTU: Air Treatment Unit;
3) Set of channellings which insufflate the new air and extracts the indoor air;


Figure 13_ Chiller


Figure 14_ RTU

4) Technical Management Centralized

The RTUs are particularly complexes because of its various functions: outdoor air filtration; outdoor air insufflation on channelings; indoor air filtration; temperature control; control of air flow insufflation as return function of thermal loads; and, heat recovery by "heat wheel" high efficient. There are RTUs for three sites of the Teather: atrium, auditorium and stage. These three sites have a huge open volume: the atrium has three floors, the auditorium has four floors, and the stage has five floors fully open. The RTUs were designed to distribute the air in these volumes.

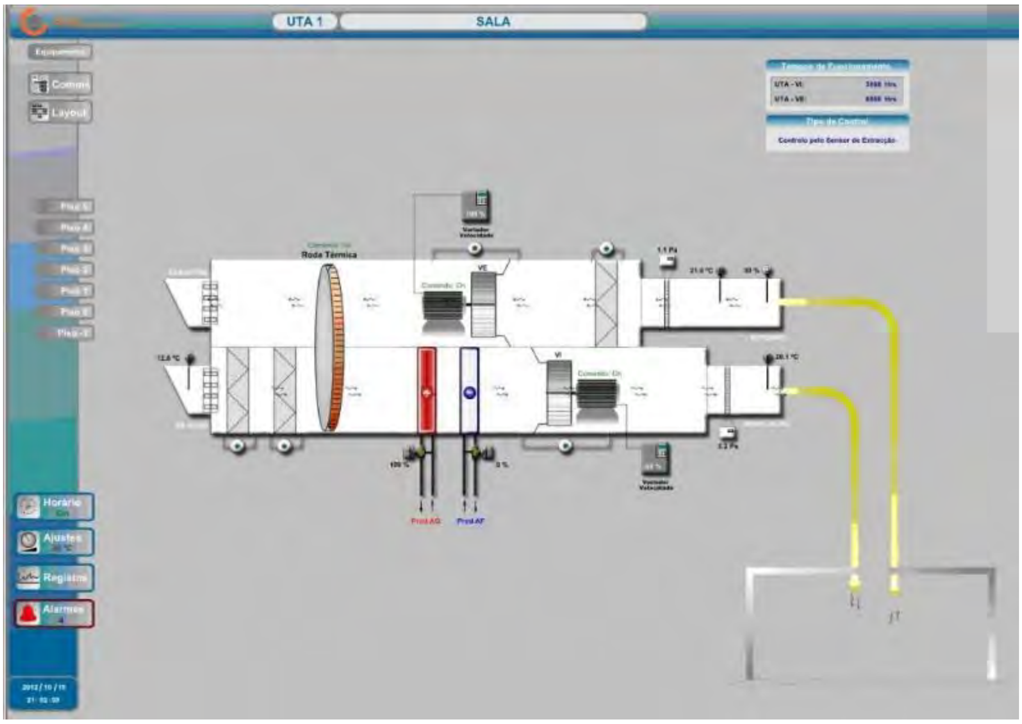

Figure 15_ Interior scheme of RTU

The offices are equipped by a unit independent air conditioning. This allows controlling offices' temperature without using the Chiller and RTU.

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- **Photovoltaics**

  The building is equipped with solar panels that support the energy consumption in renewable and ecologically profitable sources. There were installed solar thermodynamic heat sources of 3rd generation for the hot water systems of the bathrooms.

Figure 16_ Solar panels of Cineteatro Louletano

iii. Passive system

1) Natural ventilation

The entrance of fresh air is controlled by RTUs (explanation above), so, the building does not need the natural ventilation. However, there are conduits for evacuation of moisture and smell, especially in water wells and sewage from bathrooms. There are mechanisms for opening windows in the occasion of fire smoke extract.

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Also, all the windows have a system to be manually open for exterior air entrance, mainly for the offices.

iv. Sound insulation

Acoustic aspects were contemplated to ensure acoustic insulation inside and outside of building.

Studies were made to understand and evaluate the behaviour of the sound in the closed space, to avoid echoes, sound effects and for effective insulation from outside noise.

2 GENERAL OBJECTIVES

Have been equated all aspects related to energy consumption and the management and maintenance of the technical infrastructure to control and optimize any wastage that may occur due the irregular use of the spaces of the Theatre.

In the refurbishment work, technical materials and architectural solutions were used and constructed in accordance with the Regulation of Energy Systems and Climate of Buildings (RSECE).

a) Reducing harmful environmental emissions;
b) Reduction of energy consumption and peak energy use;
c) Reduction of energy losses;
d) Sound insulation;
e) Insurance of comfort and interior well-being;
f) Maximum reduction of the environmental impact, and the use of raw materials;

g) Integration between new technological improvements and the existing building.

3 GENERAL STRATEGIES

Cineteatro Louletano is devoted to current shows. The Architect of restoration project, Luís Durão, underlined a specific aspect:

> (…) due its characteristic of room for shows, it is foreseeable the high electrical energy consumption when the production of cultural events that is devoted (…)

The reasons for the high electricity consumption are:

- The three main parts of the building have a huge open volume: the atrium has three floors open, the auditorium has four open floors, and the stage has five open floors;
- In the shows are used lamps of low energy efficiency *(please see above the point Passive measures – Ligthing)*;
- The HVAC cools the heat dissipated by the scenic lighting of the auditorium and sends the temperature, in a comfortable range acceptable, for the public and for the equipment.

As mentioned above, Cineteatro has high energy consumption. In the sense to solve this issue, the HVAC is programming weekly according the cultural schedule of the auditorium. This solution guarantees that all equipment only work when it is necessary, and allows saving on monthly energy bill. This control it is possible because HVAC is equipped with a Centralized Technical

Management (GTC) which allows schedule the hours of operation of various equipment (e.g., chiller, UTAs, etc.).

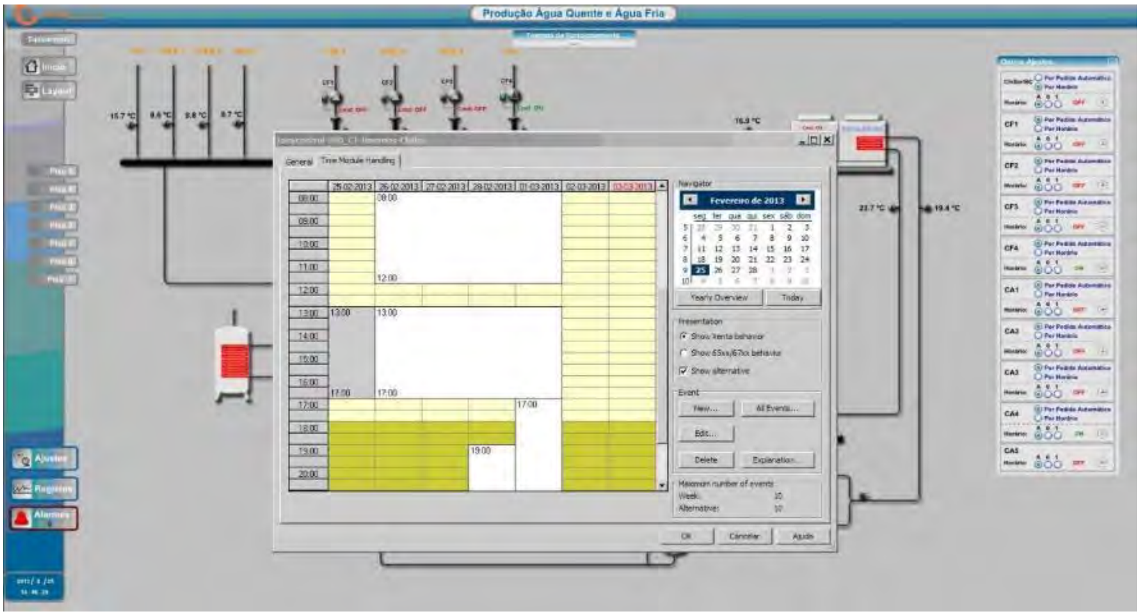

Figure 17_ Example of HVAC centralized management

The GTC is a direct result of energy efficiency measures contemplated in the restoration project of Cineteatro Louletano (2007).

To control this task was developed a programme schedule to supervise the equipment where HVAC operates. The chart includes an energy consumption registration of the main equipment in kWh (kilowatt-hour). The results of the last years identified that Cineteatro energy consumption is directly related with the use of the auditorium and stage.

CINE-TEATRO LOULETANO **HORÁRIO SEMANAL DO AVAC** Rubr. : __________

Semana do ______ de ____________________ ao ______ de ____________________ de 20_____

Preencher registo digital AVAC_Consumo01_vnn : ____ / ____ / 20____ ____H____ **Média/dia :** ________ **TOTAL :** ________	QEAVAC 1	QEAVAC 2	QEAVAC 3	DESENF.	CHILLER	UTA 1	UTA 2
	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]

EVENTOS / EQUIPAMENTOS	Seg	Ter	Qua	Qui	Sex	Sab	Dom
CHILLER Verificar Ajuste Horários □		8 - 18	8 - 18	8 - 18	8 - 18		
UTA 1 – Sala de espectáculo ____ ºC □ Velocidade: ____% Máx. ArNovo: ____ºC Insuf: ____ºC Retor: ____ºC		13 - 18		13 - 18			
UTA 2 – Palco ____ ºC □ Máx. ArNovo: ____ºC Insuf: ____ºC Retor: ____ºC		13 - 18		13 - 18			
UTA 3 – Bar / Átrio ____ ºC □ Inverno: 25 ºC Verão: ____ºC		8:30 - 18	8:30 - 18	8:30 - 18	8:30 - 18		
VC's 1 - Camarins 1.1 [1] e 3.2 [2]/ Sala Técnica apoio de cena [S.de Reunião]		8:30 - 18	8:30 - 18	8:30 - 18	8:30 - 18		
VC's 2 - Circulação 0.2 / Circulação 0.3 / Atrio Circulação 1.4		9 - 18	9 - 18	9 - 18	9 - 18		
VC's 3 - Átrio e Circulação 1 / <u>Cabine Projecção</u>/ Sala do Pessoal Piso 2 [Camarim 5]/ Camarim Colectivo [4] / Circulação 3.4		9 - 18	9 - 18	9 - 18	9 - 18		
VE 0.1 - Central Segurança / Sala Bombeiro	4 - 6 9 - 11 15 - 17 21 - 23	4 - 6 9 - 11 15 - 17 21 - 23	4 - 6 9 - 11 15 - 17 21 - 23	4 - 6 9 - 11 15 - 17 21 - 23	4 - 6 9 - 11 15 - 17 21 - 23	4 - 6 9 - 11 15 - 17 21 - 23	4 - 6 9 - 11 15 - 17 21 - 23
VE 0.2 - Posto de Transformação	ON ALL DAY [sempre ligado]						
VE 4.1 - Bar		13 - 18	13 - 18	13 - 18	13 - 18		
VE 4.2 - Cabine de Projecção (ligar também <u>VC 3</u>)							
VE 4.3 - Instalações Sanitárias	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00
VE 5.1 - Sub-Palco	5 - 7 11 - 15 19 - 22	5 - 7 11 - 15 19 - 22	5 - 7 11 - 15 19 - 22	5 - 7 11 - 15 19 - 22	5 - 7 11 - 15 19 - 22	5 - 7 11 - 15 19 - 22	5 - 7 11 - 15 19 - 22
VE 5.2 - WC's Camarim 1.1 [1] e 3.2 [2]	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00	1 - 4 8 - 00
VE 5.3 - Central Bombagem Piso -1	4 - 8 12 - 16 21 - 00	4 - 8 12 - 16 21 - 00	4 - 8 12 - 16 21 - 00	4 - 8 12 - 16 21 - 00	4 - 8 12 - 16 21 - 00	4 - 8 12 - 16 21 - 00	4 - 8 12 - 16 21 - 00
VI 4.1 - VC's Circuito 1 e 2 [e ar novo]	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00
VI 5.1 - Ar Novo VC's	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00	2 - 4 8 - 00
VPI - Pressurização Escadas	SEM HORÁRIO [comando pela Central de Detecção de Incêndios]						
VED - Desenfumagem	SEM HORÁRIO [comando pela Central de Detecção de Incêndios]						

Ficheiro: C-T_AVAC_HorarioSemanal_vosA.xls, Folha: HorarioSemanal 1 - 1

Figure 18_ Chart to control the weekly use of HVAC

4 REFERENCE

Julião Azevedo, Paulo Azevedo, Luis Durão et Isabel Azevedo (n.d.), *Cineteatro Louletano: Remodelação e* Restauro, *Projecto de execução - Arquitectura*, Memória descritiva e justificativa.

Julião Azevedo, Paulo Azevedo, Luis Durão et Isabel Azevedo (n.d.), *Cineteatro Louletano: Remodelação e* Restauro, Caderno de Encargos.

Web sources:

Cineteatro website:
http://cineteatro.cm-loule.pt/default.aspx

Loulé Council website:
http://www.cm-loule.pt/pt/menu/23/historia.aspx

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