Pathology Analysis and Intervention at the Pavilhão Mourisco Roof Terraces—Rio de Janeiro, Brazil

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Abstract The Pavilhão Mourisco, designed in Moorish revival, is the icon of Fundação Oswaldo Cruz. Listed in 1981 as National Heritage, the building nowadays holds the foundation's historical collections and makes room for some administrative personnel. The building is subject to severe wind conditions, acid rain and pollution, which all accelerate the deterioration rate of the building's external elements. The Department of Historical Heritage at Fundação Oswaldo Cruz has been developing emergency actions for safeguarding the building, but rainwater infiltration is a recurring issue. In order to develop an accurate plan to reverse this hazard, an analysis of the pathologies in place and of the department archives had to be carried out, as well the testing of the previous waterproofing solutions for that area. After that, the department developed a restoration project in order to restore the waterproofing system for the terraces, involving work on the external elements including decorative mortars, ceramic tiles and copper drip edges. The last physical intervention had the objective of stopping the deterioration processes and their consequences in order to preserve the building and the institution's collections.

Keywords Case study · Cultural heritage · Pathology analysis · Waterproofing · Mortar · Fiocruz

1 Public Health and Architectonic Preservation

The Instituto Soroterápico Federal (Brazilian Federal Serotherapy Institute), now known as Fundação Oswaldo Cruz (Fiocruz), was founded in 1900 with the goal of producing serums and vaccines against the bubonic plague, also known as the black

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plague, and other diseases that afflicted many inhabitants at the time. After the designation of Oswaldo Cruz as director, in 1902, the Institute expanded its activities and became involved in research and experimental medicine.

Oswaldo Cruz (1872–1917), physician, bacteriologist and epidemiologist, is renowned for his position as Public Health Officer and founder of the Oswaldo Cruz Institute. He studied Medicine in Rio de Janeiro and went to Paris to specialize in bacteriology at the Pasteur Institute,[1] in 1896. Upon returning to Brazil, Cruz engaged in the combat of the bubonic plague and was soon appointed as general director of the Instituto Soroterápico Federal. He started a series of sanitation campaigns, using the Institute as technical–scientific base, and battled yellow fever and smallpox.

Fundação Oswaldo Cruz is a scientific institution for research and development in biomedical sciences. Fiocruz was not confined to Rio de Janeiro, where its main campus is located,[2] and collaborated in the occupation of the Brazilian countryside through scientific and sanitary expeditions. Today, the institution has a broad range of responsibilities towards to the health and well-being of the Brazilian population. Fiocruz contributes to improving health mainly through its support to the Sistema Único de Saúde (National Health System[3]), its proposals on public health policy-making, its research activities, its scientific expeditions and the reach of its health services and products.

In spite of being an institution dedicated to scientific and health care research, Fiocruz has a unit—the Casa de Oswaldo Cruz—that focuses on its history, memory and cultural heritage. It is the Fiocruz technical and scientific unit responsible for the preservation of the foundation’s memory, as well as for researching, teaching, documenting and divulging public health and biomedical sciences History in Brazil.

At the institution's historic site, the visitor will find important architectural specimens listed as Brazilian national heritage, with large urban and landscape potential. The preservation of this heritage is the responsibility, since 1989, of the personnel[4] from the Department of Historical Heritage (DPH) at Casa de Oswaldo Cruz. Since it was established, the department has been developing emergency actions, intervention plans and restoration projects regarding the buildings and their collections’ safety and integrity.

[1]Named after Louis Pasteur (1822–1895), French chemist and microbiologist, renowned for his discoveries of the principles of vaccination.

[2]Fiocruz has offices in Rio de Janeiro, in five other Brazilian capitals (Belo Horizonte, Salvador, Recife, Manaus, and Curitiba), and in Maputo, Mozambique’s capital.

[3]The Brazilian public health system.

[4]Architects, historians, conservators, and engineers.

2 The Moorish Pavilion at Fundação Oswaldo Cruz

One of Fiocruz's historic buildings is the Pavilhão Mourisco, designed in Moorish revival style and built from 1905 to 1918. The building is the icon and part of the Pasteur Square, along with other three buildings[5]. This ensemble made up a space for scientific research and vaccines and serums production, in the beginning of the activities of the Instituto Soroterápico Federal. Pavilhão Mourisco now holds the Foundation's historical collections and makes room for some administrative personnel and the Foundation's Presidency (Fig. 1).

Luiz Moraes Jr. designed the Pavilhão Mourisco as a request from Oswaldo Cruz, to house the Chemistry and Physics laboratories of the Oswaldo Cruz Institute, one Library, the Museum of Pathologic Anatomy and some dormitories and workshop rooms. A sketch by Oswaldo Cruz of a two-storey, two-towered building was a starting point for the architect. The neo-Moorish style of the building follows that of the Alhambra[6] in Granada, south of Spain, and of the Meteorological Observatory of Montouris, in Paris—which Cruz visited during his studies at the Pasteur Institute.

Eclectic by its nature, the building combines two or more styles and decoration tendencies and is one of the few neo-Moorish buildings still standing in Rio de Janeiro. It was designed following English and Portuguese influences, such as the "H"-shaped plan with a vast staircase in the main hall, and a separate structure for the bathrooms. The ornamentation in Moorish patterns follows the fashion in Europe with the medieval revival movements. In this case, it brings out the architecture as art, through a romantic point of view—bringing an aura of magic to the "Palace of Science", as Oswaldo Cruz intended to call the pavilion (Figs. 2, 3, and 4).

Most of the materials used in the construction were brought in from Europe, as well as the (Portuguese, Spanish and Italian) specialised workers. Sand and stone were extracted from the former Instituto Soroterápico Federal site, and the wood came from local shops (Fig. 5).

The ceramic materials, such as bricks and roofing and flooring tiles, came from Marseille, France, and the light fixtures, the steel for the structure and ironclad windows and staircases, from Germany. The cement and the white Villeroy-Bosch ceramic tiles, for the laboratories, came from England. The marble is Italian, and the decorative tiles are Portuguese, by Bordallo Pinheiro (Benchimol 1990).

The building had the most modern equipment of its time, such as an elevator, telephone, heating, and gas systems for the laboratories and a clock system for the entire building. The ground floor of the pavilion housed all of its laboratory

[5]Pavilhão para Estudo da Peste (also known as Clock Pavilion, 1904–1905), Cavalariça (the Mews, 1904–1905), and the Pavilhão Quinino (for the production of the Quinine, 1919–1921).

[6]Built between 1238 and 1492, served as a palace, citadel, and fortress.

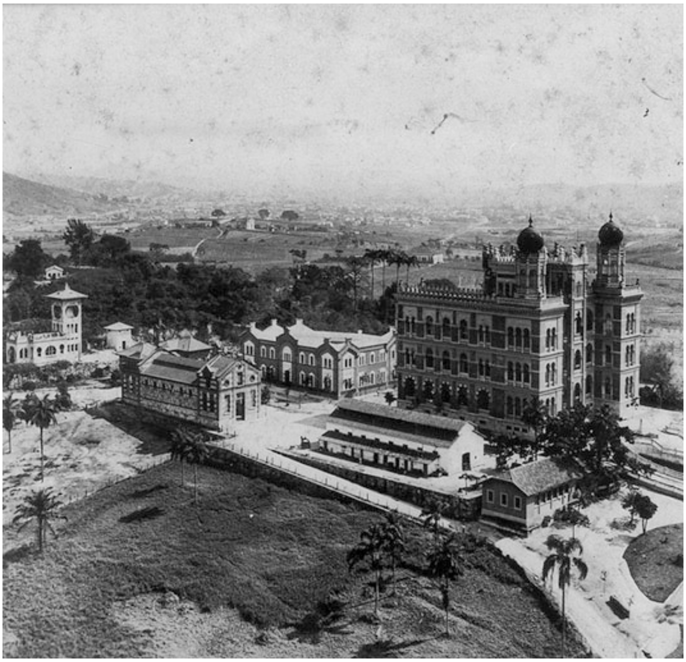

Fig. 1 View from the Instituto Oswaldo Cruz in the early 1920s (All images belong to the Casa de Oswaldo Cruz archives.)

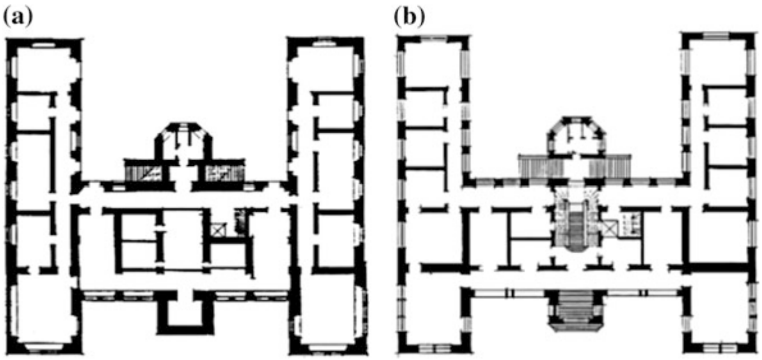

Fig. 2 Pavilhão Mourisco's ground-level (**a**) and first-floor (**b**) plans, respectively

infrastructure. In its rooms, one could find a frigorific chamber, a gas compression machine, centrifuges and electrical mixers, and shredders, for example (Fig. 6).

As the lines of the "Light and Power Company" were not installed in the region until the 1920s, all the electrical appliances from the Instituto Soroterápico Federal

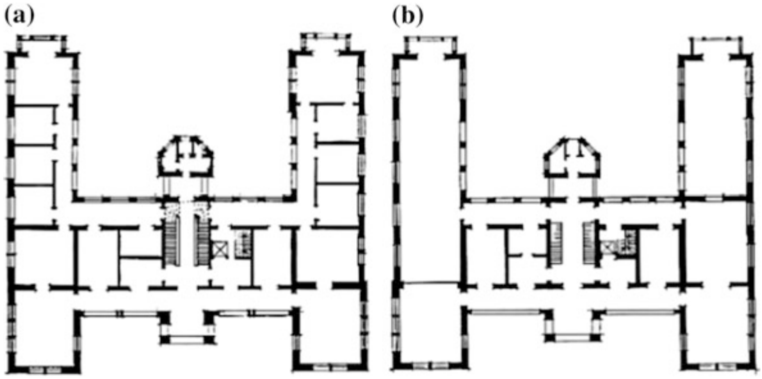

Fig. 3 Pavilhão Mourisco's second-floor (**a**) and third-floor (**b**) plans, respectively

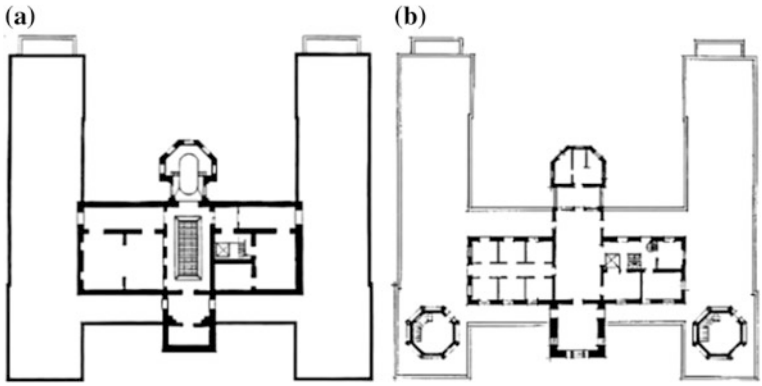

Fig. 4 Pavilhão Mourisco's fourth-floor (**a**) and fifth-floor (**b**) plans, respectively

ran on a local power plant with two generators—one with a gas engine, the backup being powered by petrol (Benchimol 1990).

The Pavilhão Mourisco is the main component of the Manguinhos architectonic and historical nucleus, listed nationally by the Instituto do Patrimônio Histórico e Artístico Nacional (Iphan).[7] It was strategically set on one of the hills in the region, to be seen from far away, and its position makes the best possible use of winds and sunlight.

The former Instituto Soroterápico Federal established its headquarters in a campus atop a hill facing the sea, located in a region surrounded by mangroves, although a lot has changed in the area since its foundation. Throughout one century, Fiocruz's historic buildings have witnessed several changes in the surrounding area: landfills that pushed the seashore kilometres farther away, the opening of three

[7]Iphan is the Brazil's Institute for Historic and Artistic Heritage.

Fig. 5 Pavilhão Mourisco in 1911

high-traffic roads, and the establishment and extinguishment of industrial plants such as an oil refinery.

Most of the damage identified on the historic buildings at Fiocruz is related to the natural ageing of the materials and lack of maintenance, but the pathologies found on the buildings are also due to weather conditions and climate change in the region. The location of the Pavilhão Mourisco, atop a hill, makes it subject to severe wind conditions, acid rain, pollution and the deposit of salts coming along with sea breeze, which all increase the deterioration rate of the building's external elements.

The Fundação Oswaldo Cruz Presidency, the Instituto Oswaldo Cruz, the Biblioteca de Obras Raras (Library of Rare Books), and the Museu da Vida currently use the building. Iphan listed the Pavilhão Mourisco as a national landmark building in 1981. Throughout the years, the Department of Historical Heritage has studied the building's history, its structure and materials—rock, mortar, ceramic and copper, amongst others. Several restoration works have taken place at the pavilion since 1988, and the building is permanently preserved and taken care of by that department.

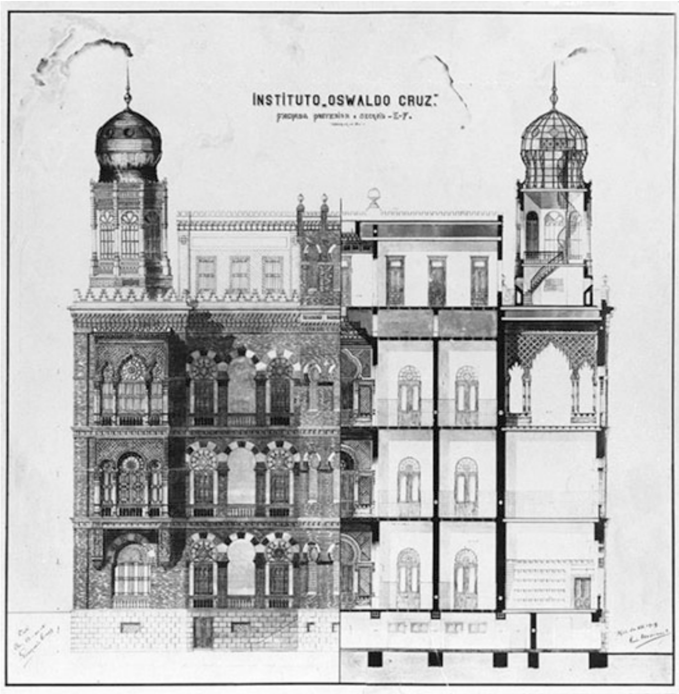

Fig. 6 Final design for the Pavilhão Mourisco—Elevation and cross section, by Luiz Moraes Jr., made while the pavilion was already being built (1908)

3 Waterproofing the Pavilhão Mourisco—A Retrospective

The Pavilhão Mourisco has suffered grave water infiltration issues throughout the years, and this has been a recurring problem. Rainwater infiltrates through the slabs of the building's roof terraces (on the fifth and seventh floors), threatening the integrity of Fiocruz's Biblioteca de Livros Raros, located on the third floor[8] of the Pavilhão Mourisco.

The terraces' slabs were constructed using "I"-shaped metallic framing filled with special ceramic bricks. Marseille ceramic tiles covered the fifth and seventh-floor terraces. Below these Marseille tiles there were copper plaques that functioned as a waterproofing system in the building's early days.

The first records of waterproofing interventions on the building's terraces are from September 1964, with a note on the Diário Oficial da União[9] (Brasil 1964, p. 8170), without mentioning, however, the scope of that intervention. Casa de Oswaldo Cruz's documents from 1976 indicate that a bituminous blanket

[8]Both the fourth and sixth floors are technical pavements and have low-rise ceilings.

[9]Diário Oficial da União is the Brazilian Official Journal, published since 1862.

Fig. 7 View from the seventh-floor terrace, with the old cement tiles (1989)

substituted the original waterproofing system and that cement tiles (60 × 60 × 04 cm) replaced the Marseille ones (DPH/COC/Fiocruz 2012) (Fig. 7).

By the end of the 1980s, several documents mentioned shortcomings of the terraces's waterproofing systems, most of them regarding damage to the ornamental stucco ceiling from the downstairs library, caused by the infiltration of rainwater.[10] Technical studies attested the need for the replacement of the bituminous blankets on the fifth-floor terrace. The intervention work that managed to substitute this bituminous blanket for a butyl one started on 1987 and focused on waterproofing both the slab and the parapet of the terraces on the fifth floor.

The technical report on this intervention states that the waterproofing system from the fifth-floor terrace showed severe infiltration issues, not only on the ceiling of the library, but on its collections as well. Engineers from the Instituto do Patrimônio Histórico e Artístico Nacional, after careful evaluation, stated that the bituminous blanket did not present the required standards for permeability, flexibility and tensile strength, recommending, thus, a substitution of the waterproofing system of the terrace, suggesting the use of a butyl blanket for that purpose (Fiocruz 1988).

During this intervention, the cement tiles and bituminous blanket were removed and the mortars on the parapets were demolished. A new blanket made of butyl rubber was installed over the slab, with its edges ending about 40 cm above the ground, over the parapet. The blanket was set using a hydro bituminous emulsion (diluted in a 50 % water solution) over a layer of settlement mortar. Once this lower blanket was dry, a cushion layer was fashioned with a bitumen emulsion and rubber flakes (with thickness varying from 2.5 to 3.0 mm) at a 1:2 ratio.

[10]Note that the fourth floor is a technical one, with a low-rise ceiling (1.8 m high).

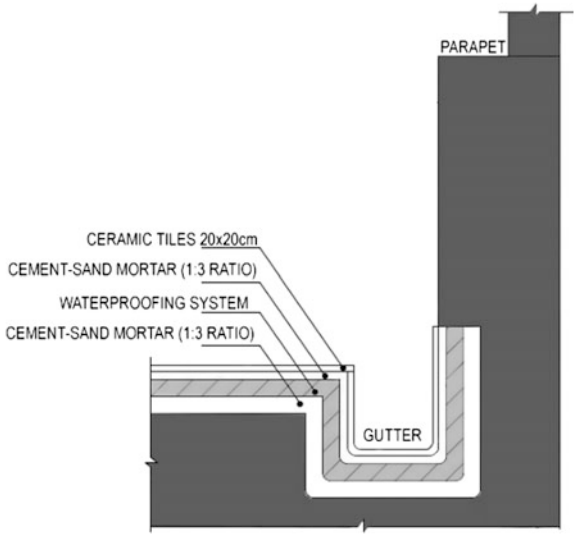

Fig. 8 Schematic cross section showing the layers of the waterproofing system around the gutters and parapets, installed in 1987

After that, a butyl rubber blanket (8 mm thick, minimum) was laid with a seam overlap of 8.0 cm, to ensure the full coverage of the terrace floor. The blanket area was then covered with bituminous felt sheets 250/15, followed by a 1:2 cement–sand ratio and 1.5 cm-thick mortar, reinforced with steel screen (Figs. 8 and 9).

New flooring was set, this time using ceramic tiles, in the hopes they would resemble and work like the old Marseille ceramic tiles. The new industrial tiles were laid using a 1:3 cement–sand ratio mortar with waterproofing additive (at a 1:15 ratio). The expansion joints were protected with a polyurethane-based, single-component, elastic sealant (Figs. 10 and 11).

In 1990, the same process took place on the seventh-floor terrace. This time, however, polystyrene plaques were added to the system before executing the butyl rubber blanket and laying the ceramic tiles, as an insulating solution, to try to reduce the heat transmission from the slab to the sixth-floor ceiling (Figs. 12 and 13).

One of the tests performed to verify the stanching of the new waterproofing system consisted on placing water on top of the butyl blanket for 72 consecutive hours, to verify leakage build up in unwanted places. During the 1990 intervention, a glass shelter was built to protect the skylight that brings light into the fifth-floor hall.

Between 1999 and 2000, the drain pipes[11] were filled with epoxy vinyl ester resin so as to bulk them up, making them stronger and fatigue resistant. Only the damaged drain pipes received this treatment. Through the examination of the scheme below, one can notice that some of the pipes were coated ten years earlier, in 1990–1991. Only 13 out of 34 pipes (38 %) of the drainage system remain

[11]They are still the original ones, made of copper.

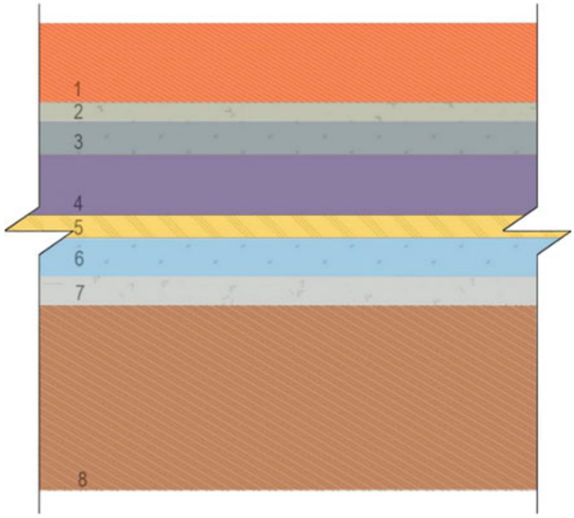

Fig. 9 Layers scheme on the butyl blanket waterproofing system, where: *1* Ceramic tile laid with cement–sand mortar (1:3 ratio) with waterproofing additive. *2* Cement–sand mortar (1:2 ratio, and 1.5 cm thick) reinforced with steel screen. *3* Bituminous felt sheets 250/15. *4* Butyl rubber blanket (8 mm thick) set with vulcanising adhesive. *5* "Cradle" composed of bitumen emulsion and rubber flakes at a 1:2 ratio. *6* Dihydric bitumen emulsion diluted in 50 % water. *7* Settlement mortar, at a 1:3 cement–sand ratio. *8* Slab (steel beam and brick stuck)

Fig. 10 Separation from the untreated surface (*on the left*) and the butyl rubber blanket (*on the right*) on the fifth floor (1988)

uncoated and do not show any kind of stress or leakage points (Figs. 14, 15, and 16).

In 2005, due to cracks spotted on the terraces, the DPH personnel hired an engineering company to run a full structural evaluation of the building. They developed a survey on the area, mapped the damage on the terraces' elements, amongst other actions. They have installed two monitoring stations to track the deformation of cracks on both terraces.

Fig. 11 Workers laying down the ceramic tiles on the fifth-floor terrace (1988)

Fig. 12 North wing terrace on the seventh floor (1990)

Fig. 13 Testing the new butyl rubber blanket with a layer of water over it for 72 h —seventh-floor terrace (1990)

Fig. 14 Construction of the shelter dome for the skylight on the seventh-floor terrace (1990)

Fig. 15 View of the shelter dome on the seventh floor (Dec 2009)

The report states that the cracks on the fifth floor result from thermal variation due to extreme temperatures in Rio de Janeiro and do not represent structural damage to the building. The report also shows that, on the seventh floor, the damage was related to the poor quality of the ceramic tiles used in the 1990s intervention (Cerne Engenharia e Projetos 2006) (Figs. 17 and 18).

The engineering company noticed the displacement of the butyl blanket in some places over the slab due to intense thermal variation at the site, which led to the fraying of the blanket next to vertical surfaces (parapets), and the appearance of cracks. The company concluded that there were no evidences of infiltration of rainwater on the slabs. Infiltration occurred only in the areas close to the external perimeter, especially on the corners of the building, with some clogged drains (Cerne Engenharia e Projetos 2006) (Fig. 19).

In 2009, DPH architects consulted several engineers to try and solve the recurring waterproofing issues at the Pavilhão Mourisco, and these consultants suggested that every waterproofing installation should be substituted by a new

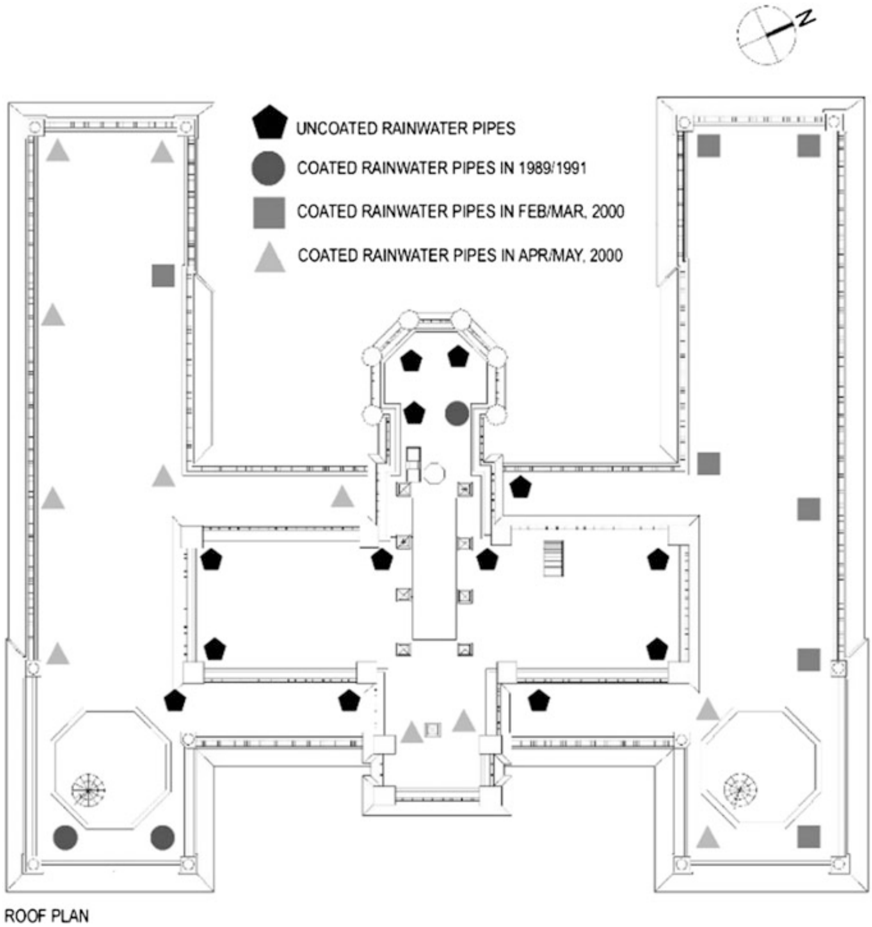

Fig. 16 Roof plan (seventh floor on the central area and fifth floor on the rest of the plan) indicating the location of the drain pipes and their interventions

system, but still they did not point out which system represented the best solution for this building (Chagas & Marques 2009).

Later on, in 2012, the DPH commissioned a new report, consulting a building waterproofing specialist, which tested the building's drainage systems and the terraces' floors for leaks. This report specifies that DPH personnel should try to solve the issues at Pavilhão Mourisco using a two-step intervention plan (Castro Saldanha Engenharia Ltda. 2012).

The first step should focus on repairing the cracks on the mortar and the terraces' external perimeter. In case said intervention does not solve the building's problems, a second step should follow, which would involve the substitution of the terraces' floor waterproofing system—working on the slab, its flooring, and casting or installing a new blanket.

Fig. 17 Monitoring station and pins fixed to the south terrace, fifth floor (Nov 2005—Cerne Engenharia)

Fig. 18 Monitoring station placed by a turret on the seventh-floor terrace (Nov 2005—Cerne Engenharia)

4 Intervention at the Eaves and Parapets from the Terraces

The last physical intervention on the building started in December 2013 and lasted one year. It had the objective of stopping the deterioration processes and their consequences, in order to preserve the Pavilhão Mourisco and the Fundação Oswaldo Cruz's historical collections.

Fig. 19 Cracks on the mortar indicating the displacement of the waterproofing blanket (Nov 2005—Cerne Engenharia)

The Instituto Oswaldo Cruz's Entomological Collection is located in the pavilion. Dating back to 1901, it is one of the most important in Latin America, carrying 5 million insects. The number increases as the Institute researchers work on new discoveries and activities on medical entomology.

The (nowadays called) Biblioteca de Obras Raras, or Biblioteca de Manguinhos, is located on the north wing of the third floor of the Pavilhão Mourisco. Its reading hall and book collections remain in the same rooms they were designed for, and all the original furniture, decoration and light fixtures were maintained (Fig. 20).

The library holds important publications on the history of biological sciences and public health, from the seventeenth to nineteenth century. The collection adds up to 30,000 books (including various first editions), magazines, journals, brochures, leaflets and theses. It is a very important collection, and its value is directly

Fig. 20 View of the Library's Reading Hall (Jul 2009)

related to the buildings', making it impossible to assess Pavilhão Mourisco's conservation without thinking about the conservation of these objects.

This intervention was the first of a two-step project, developed in 2012 and updated the following year. The intervention focused on repairing the cracks on the building's terraces' perimeters, and on reintegrating the architectural and ornamental mortar elements. The majority of the pathologies observed were fissures on the mortar surfaces, cracks on the parapets and black crust on the mortar and ceramic tiles that top the building's eaves (Figs. 21 and 22).

This intervention was planned to be held in two phases, so that the external perimeter of the Pavilhão Mourisco could be treated with less disturbance for the building's employees and visitors—always keeping an working entrance to the building. The first phase treated the surfaces on the eastern part of the building, and

Fig. 21 Pathologies: cracks on the parapet, fissures on mortar and biological growth (Feb 2014)

Fig. 22 Black crust on the external ceramic tiles (May 2014)

the second one, the western part of it. The two pictures below show the scaffolds installed for the first phase of the work.

The conservation work treated the Pavilhão Mourisco's roof terraces external elements, including decorative mortars, ceramic tiles, and copper drip edges. The battlements and turrets did not show any extensive damage and did not represent any threat to the building's structure. So, they were simply cleaned and then painted with the same formula as the mortars (Figs. 23 and 24).

The intervention work focused on stopping rainwater infiltrating through the cracks and fissures along the building's perimeter, as the latter report (Castro Saldanha Engenharia Ltda. 2012) assured that the butyl rubber blanket was still in good shape. Once again, the mortar from the inner part of the parapets was removed to try to fix the water infiltration. The edges of the butyl rubber blanket, installed in 1987 and 1990, were exposed so as to fix any deterioration process. Later, the edges were glued back to the wall and then received several layers of a plastic membrane to reinforce waterproofing qualities.

Fig. 23 Suspended scaffolds covering the front of the Pavilhão Mourisco's terraces, on the intervention's first phase (Apr 2014)

Fig. 24 Scaffolds on the seventh-floor terrace (May 2014)

A new cement mortar was laid over the waterproofing system, the paint formula to cover the new surface was determined through the analysis of the demolished mortar. The plastic membrane was also applied to every surface that could accumulate water (gutters, ornaments, etc.), and near the fissures and cracks. Some places were reinforced with a thin net below the new cement layer (Figs. 25 and 26).

The external mortar was only removed on the areas it was extremely damaged—identified through visual and physical identification, and registered in a damages survey map and in reports for this intervention work (Fig. 27).

In some places, the cracks were too deep and thus needed to be treated in a different way. The mortar on these areas was removed, the surface was treated with the elastic membrane, new cement–sand mortar was applied to the treated surface, and a plastic screen was installed to reinforce this new mortar. When the cracks were more than 1.0 cm apart, stainless steel clamps were stapled to the concrete structure, to prevent the cracks from expanding (Figs. 28 and 29).

Fig. 25 Treating the edges of the butyl rubber blanket (Jun 2014)

Fig. 26 Plastic membrane applied on top of the butyl rubber blanket in order to improve waterproofing in the lower part of the parapet (Apr 2014)

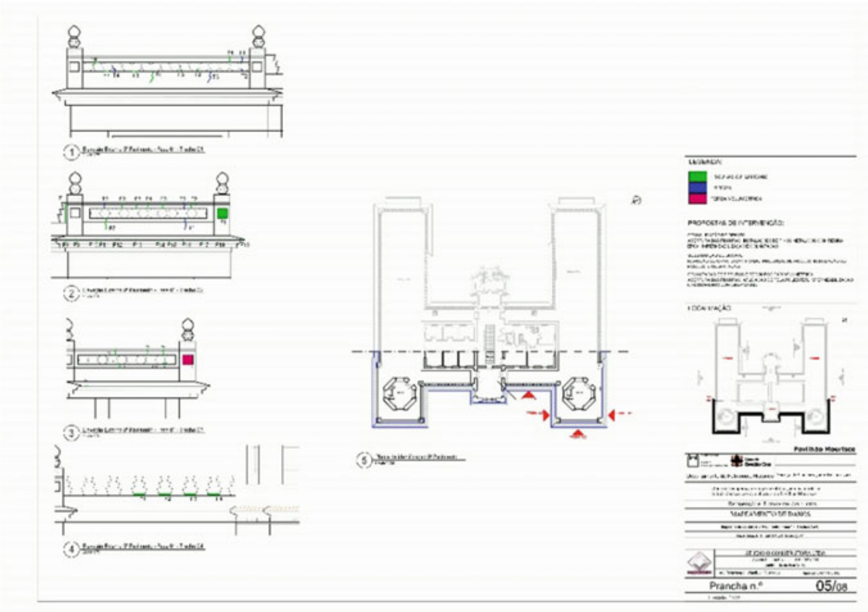

Fig. 27 Pathology and damage mapping survey—elements on the fifth-floor terrace, north wing

Fig. 28 Plastic screen used to reinforce the treatment of vastly damaged areas. The screen was installed between two layers of cement–sand mortar (May 2014)

The copper plaques located below the ceramic tiles on the eaves work as a drip edge for the building and were subject to physical intervention. The copper drip edges were removed, received anticorrosion treatment, and were finally put back in

Fig. 29 Wide cracks in the structure, treated with stainless steel clamps (Apr 2014)

Fig. 30 Structural damage seen at the seventh floor, north wing, eave: crack opening, affecting also the copper plaque (Feb 2014)

place before being welded back together and coated with automotive varnish (Figs. 30, 31, and 32).

In some places, some ornaments required in situ restoration, or even reproductions, to ensure the building's visual unity, and to prevent water infiltrating these fragile surfaces (Figs. 33, 34, and 35).

New ornaments were fashioned to substitute those extremely damaged (as shown in Figs. 34 and 35, above). First, the team identified the ornament in better conditions to be replicated. From this piece, a silicon mould was cast in situ to shape new ornaments. The new pieces were cast using a 1:2.5 ratio cement–sand mortar—determined after laboratorial analysis on existing material. In total, four ornaments were substituted—one on the frontal north wing, and three on the back of the south wing, all of them in the fifth-floor terrace (Fig. 35).

The last step taken during the first phase of the intervention work was to obtain the formula to paint the treated surfaces. The paint was produced on site using

Fig. 31 Anticorrosion treatment to a copper plaque (Apr 2014)

Fig. 32 Workmen welding back together the copper drip edge on the fifth-floor south wing terrace (May 2014)

cement, sand, lime, polyvinyl acetate, inorganic pigment and a water repellent solution. Tests were held to obtain the perfect ratio for the mortar elements on this building, as well as the colour shade that best fit with the vastly decorated façade. The same paint formula was used with on original mortar elements, and on the new, treated, areas, on both phases of this intervention (Figs. 36 and 37, above).

The solutions for the problems faced during this intervention work were achievable due to research held on site and the professional expertise of the people involved in it. Consultants were called upon to advise on techniques and materials

Fig. 33 Ornament on the fifth-floor terrace, south wing, and external wall (Sep 2014)

Fig. 34 Ornament on the fifth-floor terrace, north wing, external wall—the damage goes deep into its metallic structure (Mar 2014)

and worked alongside the DPH personnel and construction staff, in order to better perform the restoration of the mortars of this historic building (Fig. 38).

This kind of work was only possible due to intense labour, study and documentation on the Pavilhão Mourisco since the beginning of Fundação Oswaldo Cruz's Departamento de Patrimônio Histórico activities. The expertise of all professionals involved in actions held in the building over the years, recorded in reports, surveys and photographs, and kept at DPH archives, was vital to understand

Fig. 35 Same ornament after restoration (Jul 2014)

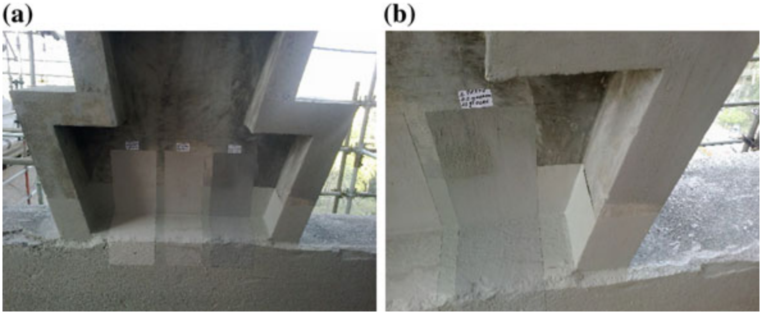

Fig. 36 Finishing paint colouring tests on the battlement (a) and detail (b) (May 2014)

Fig. 37 External aspect of the parapet and the eave after the intervention—fifth-floor terrace (Sep 2014).

Fig. 38 External aspect of the parapet and the eave after the intervention—seventh-floor terrace (Oct 2014)

Fig. 39 Today's aspect of the fifth-floor terrace, north wing (Oct 2015)

the pavilion's behaviour. This helped to develop a detailed intervention plan and better assess the restoration.

One year afterwards, the intervention has ended; it is possible to see that its objectives were achieved (Fig. 39). One cannot see infiltration signs on the ceilings from the third and fifth floors of the Pavilhão Mourisco. It is a sign that the past intervention managed to stop rainwater from finding a way through the building's perimeters, and the waterproofing system on its roof terraces is satisfactory.

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