Conservation / Sustainable Design

Heritage Challenges in Historic Urban Landscapes

VIII EAAE CONSERVATION NETWORK WORKSHOP

EDITORS
Donatella Fiorani
Giovanna Franco
Loughlin Kealy
Rodica Crișan
Stefano Francesco Musso
Teresa Cunha Ferreira

European Association for Architectural Education
Association Européenne pour l'Enseignement de l'Architecture

Conservation / Sustainable Design

Heritage Challenges in Historic Urban Landscapes

VIII EAAE CONSERVATION
NETWORK WORKSHOP

EDITORS
Donatella Fiorani
Giovanna Franco
Loughlin Kealy
Rodica Crişan
Stefano Francesco Musso
Teresa Cunha Ferreira

European Association for Architectural Education
Association Européenne pour l'Enseignement de l'Architecture

EAAE TRANSACTIONS ON
ARCHITECTURAL EDUCATION N. 68

PUBLISHED BY
EAAE, Hasselt, Belgium, 2024.

PRINTED IN
Portugal, Maiadouro

ISBN
978-90-831271-4-9

This book presents the papers written by 43 participants following the 8th Workshop CONSERVATION/ SUSTAINABLE DESIGN organized by the Conservation Network of the European Association for Architectural Education and the UNESCO Chair "Heritage, Cities and Landscapes. Sustainable Management, Conservation, Planning and Design".

The workshop was hosted in the Faculty of Architecture of the University of Porto between 21st and 24th of September 2022 and was attended by 49 participants from 23 Universities, representing 9 countries: Portugal, Italy, Romania, Spain, Ireland, United Kingdom, Brazil, Belgium and Montenegro.

The views and opinions expressed herein are those of the authors and do not necessarily reflect the opinions and beliefs of the editors. Illustrations to the text were provided by the authors. All papers were peer-reviewed.

European Association for Architectural Education
Association Européenne pour l'Enseignement de l'Architecture

U.PORTO
FACULDADE DE ARQUITECTURA
UNIVERSIDADE DO PORTO

U.PORTO
UNIVERSITY OF PORTO
FACULTY OF ARCHITECTURE

UNESCO CHAIR "HERITAGE, CITIES AND LANDSCAPES. SUSTAINABLE MANAGEMENT, CONSERVATION, PLANNING AND DESIGN"

unesco
Chair

ACKNOWLEDGEMENTS

The editors would like to acknowledge the Board of the Faculty of Architecture of the University of Porto (João Pedro Xavier and Teresa Cálix) for hosting and supporting the Workshop "Conservation/Sustainable Design" held in Porto from 21 to 24 September 2022. Also, the Editors would like to thank the Center for Studies in Architecture and Urbanism for the assistance in the secretariat and workshop organization.

Acknowledgements are due to the Municipal Council of Porto (Rui Loza, Margarida Guimarães, Ana Leite Pereira) and to the Municipal Council of Guimarães (Ricardo Rodrigues and Miguel Frazão) for the contributions to the workshop visits and introductory essays in this book.

The Editors are grateful to the Organization Committee Teresa Cunha Ferreira, Rui Fernandes Póvoas, Clara Pimenta do Vale, Joaquim Lopes Teixeira, Nuno Valentim Lopes, Pedro Murilo de Freitas, Tiago Trindade Cruz, David Ordóñez-Castañón and Domingas Vasconcelos. Special aknowledgement is due to Pedro Murilo de Freitas and Tiago Trindade Cruz for their collaboration in the production of this book.

Finally, the Editors would like to express their gratitude to the European Association for Architectural Education for the institutional and financial support of the book "Conservation/Sustainable Design. Heritage Challenges in Historic Urban Landscapes".

. Introduction

I Heritage Conservation *versus* Urban Development

II Contemporary Design *versus* Pre-existing Features

III Traditional *versus* Innovative Technologies

Minimum Intervention Options in the Constructive System of Porto Bourgeois Houses

Towards an environmentally sustainable action

Rui Fernandes Póvoas
Joaquim Teixeira

Faculty of Architecture of
University of Porto (Portugal)
Center for Studies in
Architecture and Urbanism
rpovoas@arq.up.pt
jteixeira@arq.up.pt

INTRODUCTION

Until the end of the first decade of the twenty-first century, the historic centers of Portugal's main cities, including those inscribed on the World Heritage List, remained stagnant and in a state of abandonment. The reversal of this situation occurred during the second decade, as a reaction to escape the 2008 financial crisis that translated into a large-scale implementation of mass-tourism related activities.

This is the overall picture that precedes the massive and unprecedented interventions in the built environment of the historical centers in Portugal, particularly in the city of Porto.

Despite the fact that in the last few years there has been a noticeable greater attention to intervention in the existing built environment and a slowing down of new construction, this reversal has not yet reached sufficient significance to constitute a necessary change of paradigm. There has been a significant tendency of interventions to almost completely demolish buildings and opt for their reconstruction, according to "façadism" practices. However, these options are certainly not the most appropriate in environmental terms — since they produce waste and consume resources —, nor in terms of heritage, since they often result in the loss of values.

BRIEF URBAN CONTEXTUALIZATION OF THE CITY OF PORTO

The first traces of human occupation of the territory that would serve as the settlement of the city of Porto date back to megalithic times, with the first written reference dating from the first century BC. The selection of this location is due not only to defensive reasons, but also to the fact that it is the narrowest point between the banks, and therefore the most favorable for crossing the river.

From the sixth century on, the settlement is marked by a bipolar structure, between the high level where the small walled village is located and the low level, close to the bank, related to mercantile activity (FIG. 1).

Urban growth and defensive needs determined the construction during the fourteenth century of a large wall that encompassed the entire urban area (FIG. 1).

Around the end of the sixteenth century and the beginning of the seventeenth century, the area within the walls and the one extended by the outskirts was populated with small rural settlements.

During the Spanish occupation in the first half of the seventeenth century, the port area and the river access to the city were improved, and urban planning actions were promoted that would indicate the future radial development of the city. In the second half of the seventeenth

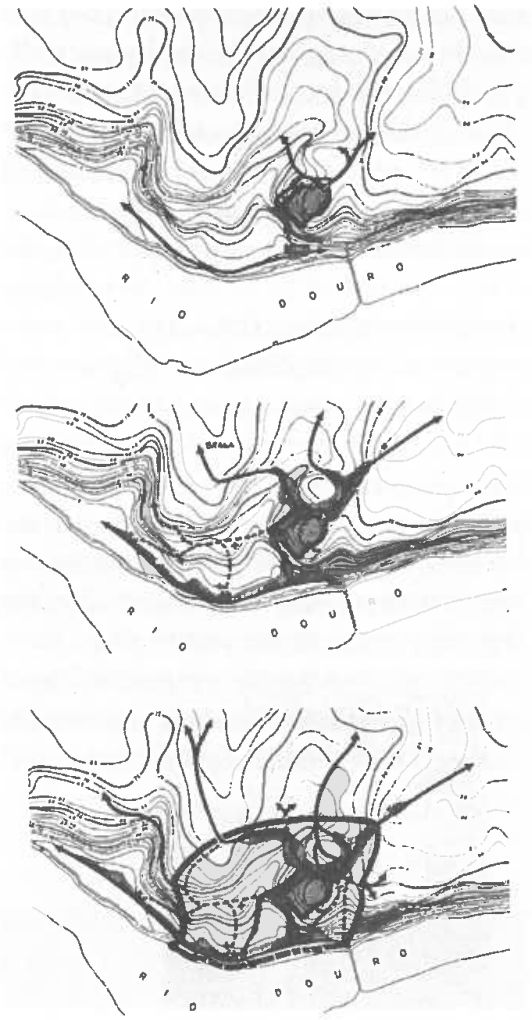


FIG. 1 Urban development phases of the city of Porto. On the left, a bipolar structure, sixth to eighth centuries. On the right, Fernandine Wall, 1334-1376.

century, after the Restoration, the advent of a mercantilist policy based on increased agricultural production and the intensification of international trade led the country into a new period of some prosperity. The city expanded, both within its walls and in its periphery, through the densification of the preexisting nuclei, almost doubling its population.

In the early eighteenth century, the country was in a good financial situation in the wake of the discovery of gold in Brazil and the signing of the Methuen treaty with England, allowing Porto to expand its economic activity as an exporting center of the most important Portuguese wine region. During this period, major urban renewal works were promoted via the exaltation and monumentalization of religious buildings and large palaces, following Italian Baroque models introduced by Nicolau Nazoni.

In the wake of the reconstruction of Lisbon after the 1755 earthquake, João de Almada e Melo founded in 1758 the Junta das Obras Públicas (Board of Public Works), the body in charge of putting into practice the new urbanistic programs using the revenues from the Companhia Geral das Vinhas do Alto Douro founded two years earlier. The urbanistic actions of the *junta* took place inside and outside the walls and aimed to promote the functional adequacy of circulation spaces and control the aesthetic quality of new buildings.

The action began by defining a new north-south articulation road axis that connected Praça da Ribeira to Praça de Santo Ovídio by partially taking advantage of the existing Rua das Flores and complementing it with the opening of Rua de São João and Rua do Almada. At the same time, the action promoted measures of sanitation and reconversion of the existing urban fabric through the regularization of the existing main exit roads. The construction of houses began to comply with the prior definition of a regular plot and the use of principles of modular systematization in the composition of the façades, although there were exceptions to this rule — as is the case of Rua de São João. This period was marked by the influence of the English neoclassical taste, which was introduced with the construction of the Santo António Hospital (1770–1834) and the English Factory House (1785–1790).

The nineteenth century began in a troubled way, first with the French invasions, which lasted until 1814, then with the Liberal Revolution in 1820, and later with the civil war between Absolutists and Liberals, between 1832 and 1834. After the extinction of the Junta das Obras Públicas in 1833, the urban management became the responsibility of the Municipality, which began a policy of road rectification, opening of new roads, construction of markets and landscaping of public spaces.

THE BOURGEOIS HOUSES OF PORTO

Two types of housing buildings can be found in Porto: the horizontal house, with two floors and of aristocratic origin; and the narrow and high-rise house, with 6 m of width on average, with five floors or more, commonly called a bourgeois house and representing the majority of the housing buildings in the city. These are single-family and multifunctional houses intended for the family's subsistence activity, usually commerce or crafts, located on the ground floor, basement and mezzanine, and for housing in the other floors. A new mono-functional type appeared from the mid-nineteenth century on, for housing purposes only.

According to Fernandes (1995), the evolution of this built environment can be systematized based on three periods: the seventeenth-century mercantile house; the eighteenth-century Illuminist house; and the nineteenth-century Liberal house.

The mercantile house originated in the medieval, walled and densified city, characterized by narrow and winding streets. This type of house occupies little floor area and developed in height up to five floors. Its multifunctional typology reconciled the family's subsistence activity (located on the ground floor) with housing in the remaining floors. Its organization does not observe any specification of the spaces, which are generally large and intended for various housing functions, with the kitchens being located on the upper floors, under the roofing (FIG. 2).

As for the construction system, in general only the walls of the ground floor are in stone masonry, and those of the other floors are in timber framing (*fachwerk*), all coated with gravel plaster and lime. The structures of the floors and roofs are also in timber, the latter being covered with thatch or canal tile.

In this period a new building type emerges on the riverfront — the narrow, long house, whose use would consolidate and expand in subsequent eras.

The Illuminist house is an example of this novelty, resulting from a parceling of narrow lots. It presents an average width of 6 m, great depth and a tendency to develop in height. They form blocks of large dimensions and present a novel feature, the curtilages, some of which with great depth. Its functional organization maintains the essentials of the mercantile type with some additional specification of functions, with the most important rooms located on the first floor and yet another novelty with the interior compartments lit from the stairwell (FIG. 3).

As for the construction system, there is a progressive replacement of exterior wooden walls with stone masonry, the imposition of tile roofing, and a greater use of glass, which will make the use of glazed frames more frequent.

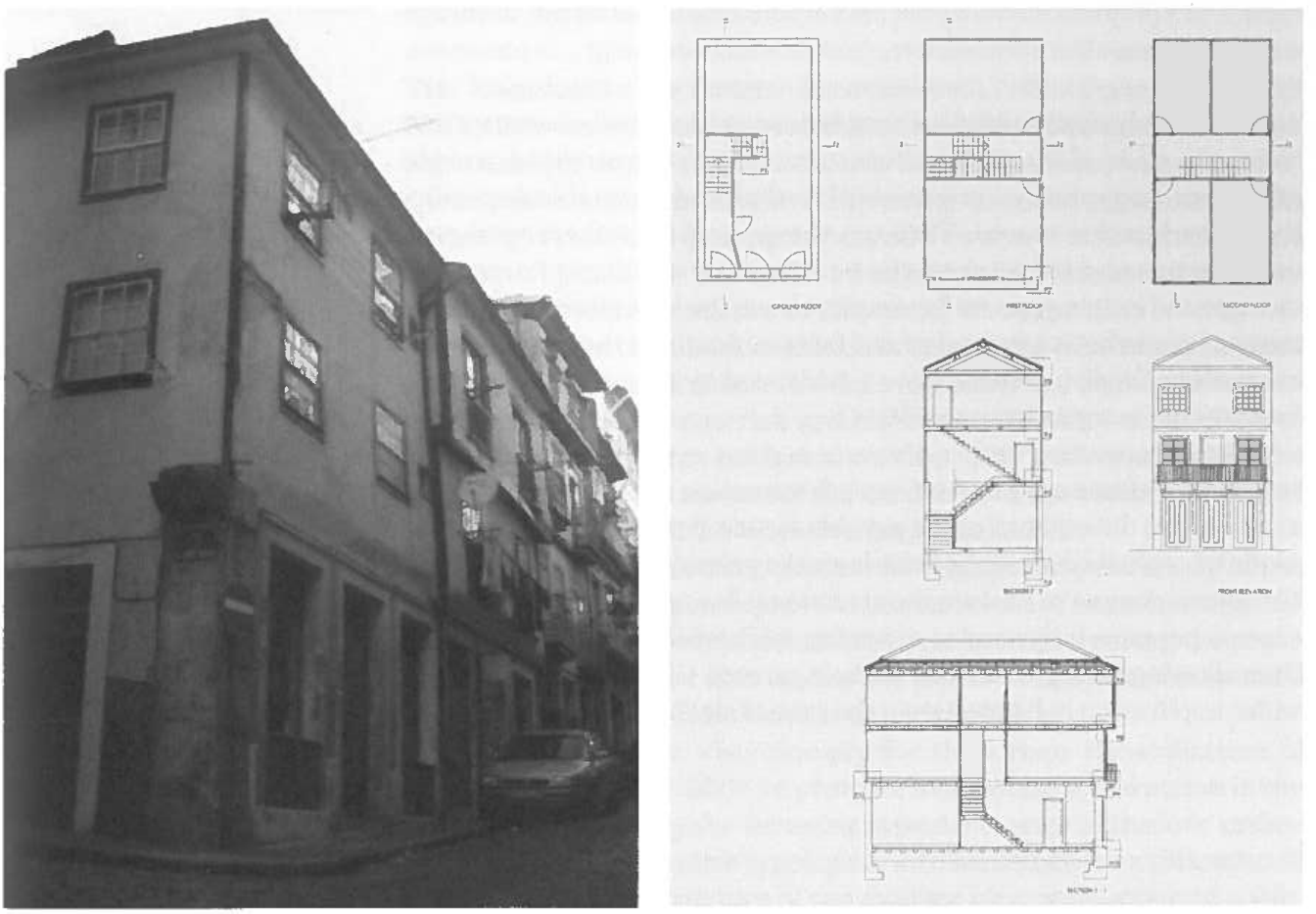


FIG. 2 Example of mercantile houses.

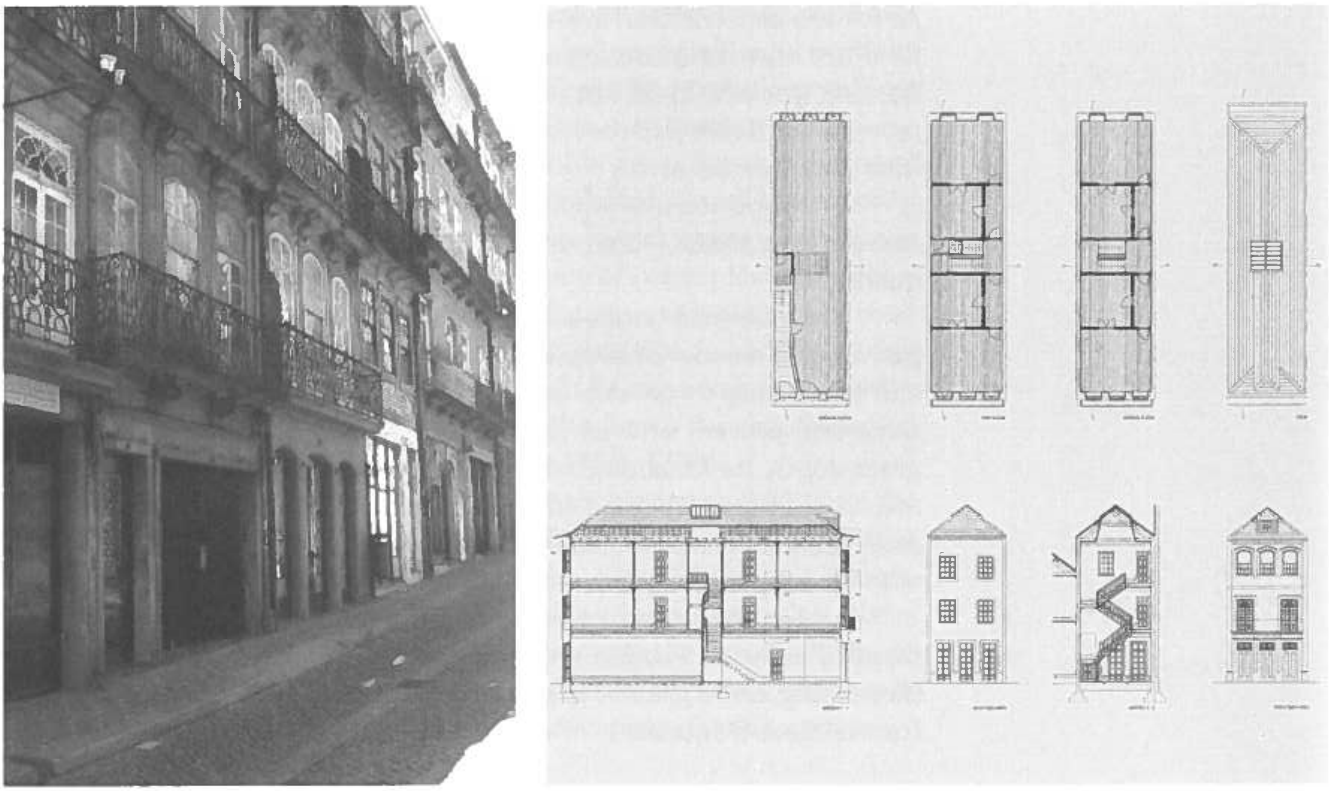


FIG. 3 Examples of Illuminist houses.

Basically, the Liberal house is a refinement of the Illuminist house model, not only in functional but also in constructional terms, although a slight increase in its dimensions, both in width and height, is observed. From the second half of the nineteenth century on, a typological variant exclusively destined for housing functions appeared, characterized by an elevation of the ground floor in relation to the street to provide greater privacy, and by a greater, well marked and hierarchical specificity of the interior spaces. Thus, on the ground floor there were now social rooms and the kitchen, the bedrooms on the upper floors, with storage and lodging spaces for employees on the lower floors and basements. Its aesthetic expression and taste maintained the cultural influence of the English community, as evidenced by the presence of some features of Georgian houses (FIG. 4).

In constructive terms, there is a great systematization of the techniques of masonry and stonework execution and a greater optimization of the dimensions of the wooden structures' elements. The technique of asphalt coating the exterior walls gained wide application and tile coating began to replace the traditional lime plaster. The Marseille tile was progressively used to cover the roofs, which gained more slope, thus allowing for a greater use of their garrets. Glass started to have a wider application in houses, as in the case of skylight lanterns.

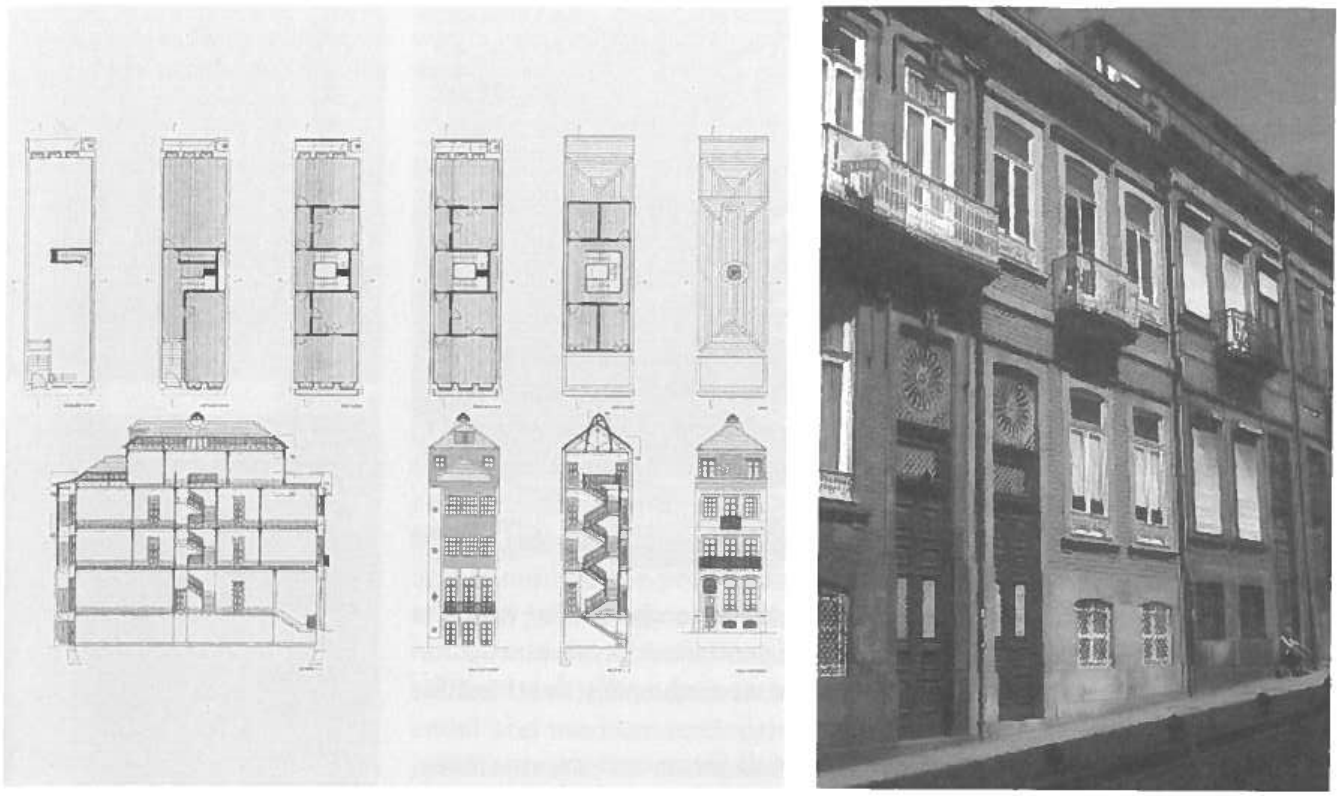


FIG. 4 Examples of liberal houses.

INTERVENTION IN THE BUILT ENVIRONMENT — FROM POST-CARNATION REVOLUTION (25 APRIL 1974) TO THE PRESENT DAY

The Commission for Urban Renewal of the Ribeira/Barredo Area (CRUARB) was created in September 1974 with the main goal of intervening in a deeply degraded historical area to provide decent housing conditions to the resident population. This entity was later placed under the authority of the Municipality and expanded its area of action until the end of its activity in 2003, albeit with a relatively small number of interventions. The recurrent practice of this entity throughout its activity was governed by the complete demolition of the interiors (or what remained of them) and reconstruction in reinforced concrete, among other contemporary industrial materials and techniques (FIG. 5). Despite the controversy surrounding its performance, this entity's role was decisive for the presentation and success of the candidacy of the Historic Center of Porto (CHP) to UNESCO's World Heritage List in 1991.

CRUARB reversed the process of degradation and decay of the most problematic areas, improved the conditions of some housing and public spaces, and promoted multiple social activities among the population, but still was not able to stop the process of population loss and abandonment in the CHP, which began in the 1980s.

The SRU Porto Vivo (Society for the Urban Rehabilitation of Porto) was created in 2004 to promote management and action in the CHP characterized by the following aspects: change of the lots' cadastral matrix and respective typologies, with consequent modification of the morphotyping structure of the existing city; destruction of a substantial part of the heritage via the complete demolition of the interiors of the buildings; reconstruction of the interiors using industrialized

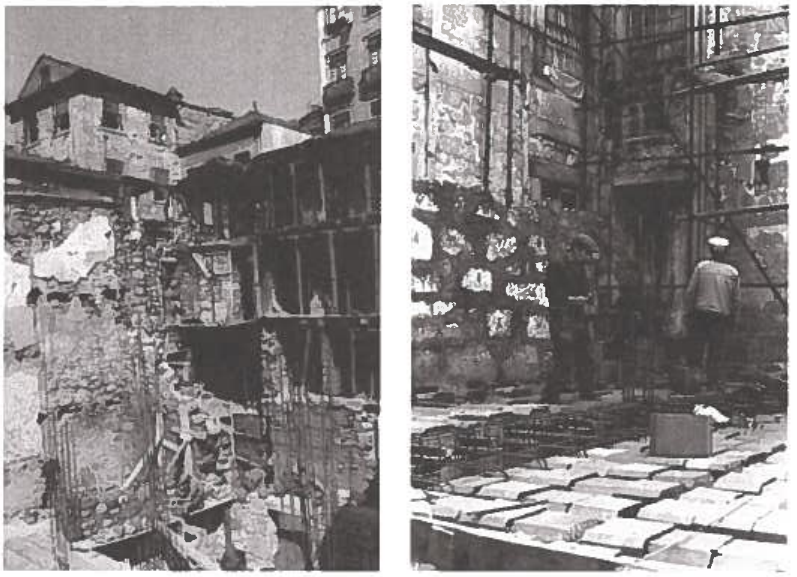


FIG. 5 Interventions undertaken at the beginning of CRUARB's activity.

construction systems, without assessing their compatibility with the scarce preexistence (FIG. 6); promotion of gentrification via the option for high standard housing or housing almost exclusively destined for tourism and similar activities.

Although the damage caused by small interventions was occasional, the replication of such interventions tended to create significant dissonances and ruptures that compromised the heritage integrity of the ensembles. This is what happened with the destruction of stonework elements for the installation of infrastructure, or the replacement of existing painted wooden frames with new ones made of aluminum or PVC, with a different geometry and function from the original ones (FIG. 7).

The data from the last population census survey conducted in 2020 reveal that the downward trend in population loss continued, which means that the management of the SRU Porto Vivo was not able to fix population in the CHP or reverse its emptying process, which has occurred since the early 1980s (FIG. 8). The proclaimed repopulation of the CHP as one of the main goals of the SRU Porto Vivo has resulted in an artificial dynamic set in motion by the recent unprecedented phenomenon of a multiplicity of activities associated with mass tourism, which, as is well known, is extremely fragile, not only because it feeds on fashion trends, but also because it depends on massive inflows of people on a global scale. Besides being harmful to the environment, this trend can lead an economic system to collapse, as happened recently with the impact of the COVID-19 pandemic, or with the war in Eastern Europe.

FIG. 6 Three early large-scale interventions carried out by SRU Porto Vivo.

FIG. 7 Once-off interventions that, when replicated on a larger scale, cause considerable damage to urban ensembles.

THE RELEVANCE OF HERITAGE REHABILITATION

Our current model of society has been unable to solve people's problems and the progressive awareness of its unsustainability in terms not only environmental, but also economic, social and political, calls for an urgent paradigm shift. Regarding the building stock, this change involves enhancing its efficiency and extending its useful life via the resumption of good practices in the interventions to be carried out.

According to the Vienna Declaration (FERP 2009), the intervention in the built heritage is the one that best addresses the necessary change towards a more environmentally, economically and socially sustainable society. In fact, intervention in old buildings uses traditional environmentally friendly materials and construction techniques, preserves the embodied energy and material resources used in the past, and minimizes the production of new materials, which are more expensive and potentially more harmful from an ecological point of view.

In addition, intervention in traditional buildings requires more skilled labor, thus generating more jobs, particularly in the case of small and medium enterprises; another advantage is that it attracts private sector investment (through public sector subsidies and tax incentives); moreover, in the heritage area, it promotes the growth of cultural tourism, bringing long-term economic and social benefits.

In social terms, heritage is intrinsically associated with a sense of local and national identity, and therefore its enjoyment is a key component of social cohesion and integration and a sense of community. Historic areas currently boast attractiveness in terms of quality of life and are therefore chosen as places to live and work.

Compared to new construction, the intervention in old buildings also presents advantages in terms of cost reduction regarding demolition work, licenses and fees, as well as reduced costs and constraints regarding the construction site, while minimizing disruption to urban traffic.

The growing trend towards the application of standards and requirements — which tend to be indifferent to the specificities of the existing building stock — emerges as a threat not only to the safeguarding of heritage, but also to the practice of environmentally sustainable actions. In fact, the blind application of current standards to old buildings — whose performance is still poorly studied — may lead to interventions that result in profound changes, with consequent loss of heritage values, in addition to the negative environmental impact. Improving the efficiency of old buildings should therefore be approached with moderation and be guided by principles of action that allow a balance to be found based on what is strictly necessary and on safeguarding and valuing the existing built heritage.

In conclusion, the desirable and necessary change towards a truly sustainable architecture in environmental, economic and social terms should be governed fundamentally by the intervention in the existing built environment, following minimal intervention principles based on maintenance and conservation, in order to preserve the identity and authenticity of the existing heritage values.

MINIMAL INTERVENTION

Certainly, intervention in current historic built environment has become highly complex due to the gradual loss of knowledge about the behavior of old buildings and the disappearance of traditional ways of building. It is therefore important to develop intervention strategies that enable informed and qualified actions by technicians and builders.

Currently, it is the academies and their research centers that are at the forefront of the recovery of knowledge about traditional building techniques and materials. Among other contributions, this trend has enabled the conception of intervention methodologies for the dissemination of good practices to safeguard our built heritage.

Intervention in the construction system of Porto's bourgeois houses must be governed by principles of minimal intervention, whether in the scope of rehabilitation or of simple maintenance actions, in order to be environmentally sustainable and thus ensure the safeguarding of heritage values. The intervention options must therefore achieve a desirable balance between the negative impact on the environment and its benefits.

Although there are still no in-depth and conclusive studies on the behavior of the built environment under study, moderation regarding intervention solutions should be the central element. In this context, we present a set of solutions for intervention in the building system of bourgeois houses in Porto. These solutions were taken from Teixeira (2014), and aim to contribute to the repair of anomalies, to strengthen structural elements and to improve the performance of exterior walls, floors, roofs and exterior frames. All these proposed solutions seek to solve in a balanced way, and with minimal environmental impact, the most common problems of our built environment.

In order to comply with the principles for minimal intervention, it is necessary that the building be in a reasonable or moderate state of conservation. Unfortunately, this is not always the case, mainly due to the state of degradation of the buildings as a result of lack of maintenance due to the freezing of rents for several decades, which caused not only the decapitalization of the owners, but also the (intentional or purposeful) negligence motivated by poor urban management, which is captured by speculative interests and is responsible for the serious urban interventions carried out.

FIG. 8 Abandonment has led to the collapse of several buildings.

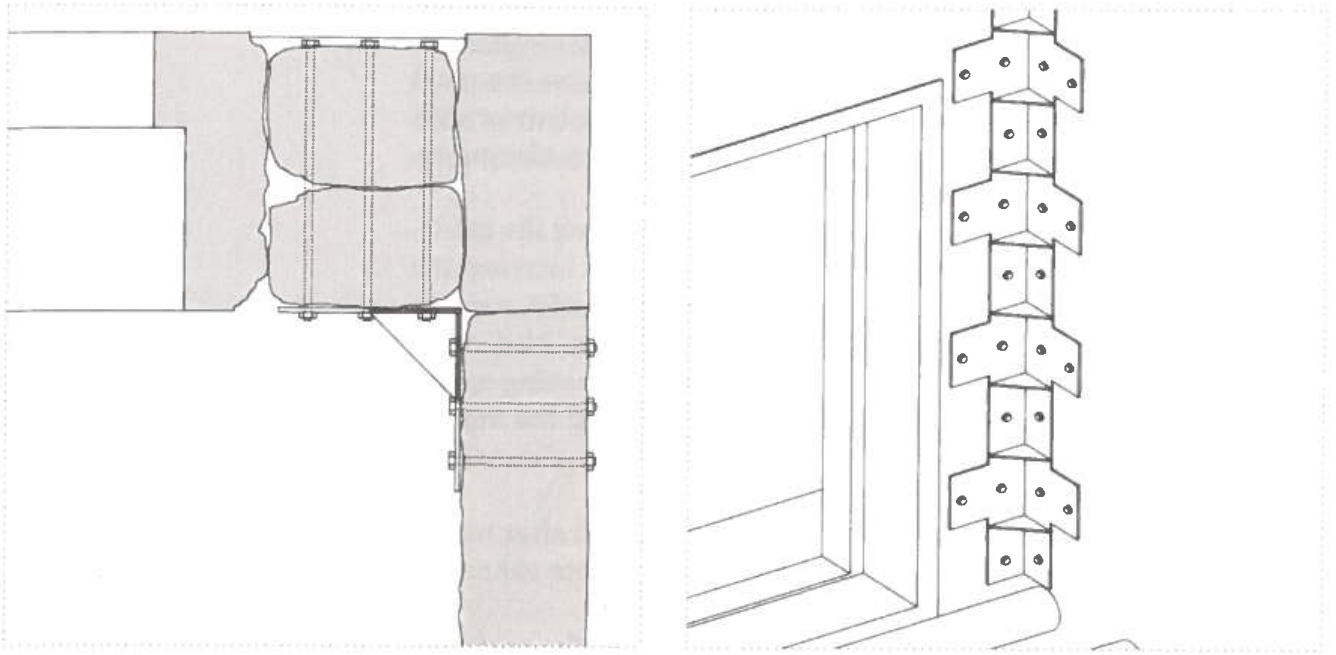


FIG. 9 Application of metal elements to reinforce a junction.

— MINIMAL INTERVENTION ON EXTERIOR WALLS

The exterior walls of the bourgeois houses of Porto are made of stone masonry (granite) and correspond to the façades (street and back) and to the joint-property walls. Although part of the area of the latter may be in contact with the outside, they are generally interior walls of the buildings and are generally shared, which can be a significant constraint in the case of isolated interventions.

The exterior stone walls are generally in a reasonable state of preservation in terms of structure; however, there may be a need for repair or structural reinforcement operations due to a very common vulnerability – the existence of voids in the masonry unit.

Structural strengthening can be due to the presence of anomalies or to the need to support an increase of the load due to changes in the use of the building. In both cases, the intervention operations should preferably use traditional techniques to ensure compatibility with the existing building and the preservation of its integrity.

The following are some examples of intervention solutions: the replacement of degraded material with new material identical to the existing one; injection of consolidants to fill cracks and voids; addition of metallic elements (FIG. 9) in the junction of structural elements or in the repair of cracks; and the application of composite materials when a greater resistant capacity is required. Although reversible, the latter should only be applied in exceptional cases, after its compatibility with the existing building system has been demonstrated.

There are several processes for solving problems related to rising dampness, but it is important to select the one that best suits the building in question. Given the characteristics of these houses, the most appropriate solutions include the introduction of a rising barrier with water-repellent chemicals, dehumidification of the wall by electro-osmosis, or the creation of ventilation channels.

Intervention on the stone walls also includes cleaning the stonework of dirt, not only for aesthetic reasons, but also to increase the durability of the stone by removing anything that is harmful, namely: soluble salts; incrustations; microorganisms; vegetation; bird droppings; dust and particles from atmospheric pollution. Cleaning operations must take into consideration the preservation of the stone's primitive surface (if any), so as to ensure the preservation of the work's original artistic aspect.

Repair of plaster coatings should only be conducted after having corrected the anomalies affecting them and whose effects cannot be concealed by the new plaster.

The maintenance process is critical for prolonging the useful life of the plasters. Therefore, it is important to schedule the operations of cleaning, treatment, correction of situations that may cause infiltrations, the timely repair of the finishing layers (plaster and paint) and filling of surface cracks.

Localized repairs should be carried out when the severity of the anomalies warrants it — for example, by treating cracks, removing salts, or filling gaps using materials similar to the existing ones.

In cases of extremely severe anomalies it may be necessary to replace part or all of the existing plaster coating. In any case, materials compatible with the existing one should be used, and more expensive and complex options should be properly considered and assessed.

In the case of *frontal*[1] walls or *tabique*[2] walls, the most frequent anomalies (warping and rotting) are basically caused by the wood structural elements as a result of the structure settling or the presence of humidity, which can lead to eventual disintegration of the coatings; these anomalies are often aggravated by the oxidation of the nails used in the joints.

Repair of wood structure elements (props, crossbeams, rafters, and stanchions) rotted by fungi or xylophagous insect attack may require partial or total replacement, depending on the size of the degraded area.

The partial replacement of a part can be done with wood equal to the existing one or by using epoxy resin prostheses for reasons of convenience. In the case of full replacement of components, new elements should be used that are the same as the existing ones regarding wood, geometry and type of connection, thus avoiding disturbing the balance of the original structural system. These repairs require inspection of the entire wall and for this purpose all the existing coating must be removed to detect possible sources of infestation. As a precautionary measure, all wood elements should be impregnated with an insecticide and fungicide product prior to applying the finishing coat.

1 Also known as "fachwerk", are timber frame walls filled with bricks or small stones.
2 Wood partition wall that consists of a light timber frame filled with planks, covered with special slats to anchor the plaster coating.

Regarding the reinforcement of structural elements as a result of wood warping or thermal creep, the simplest method is the application of composite elements glued with epoxy resins. This same process can be used in the reinforcement of joints or in the application of stirrups or appropriate metallic plates (FIG. 10) nailed to the wooden structure.

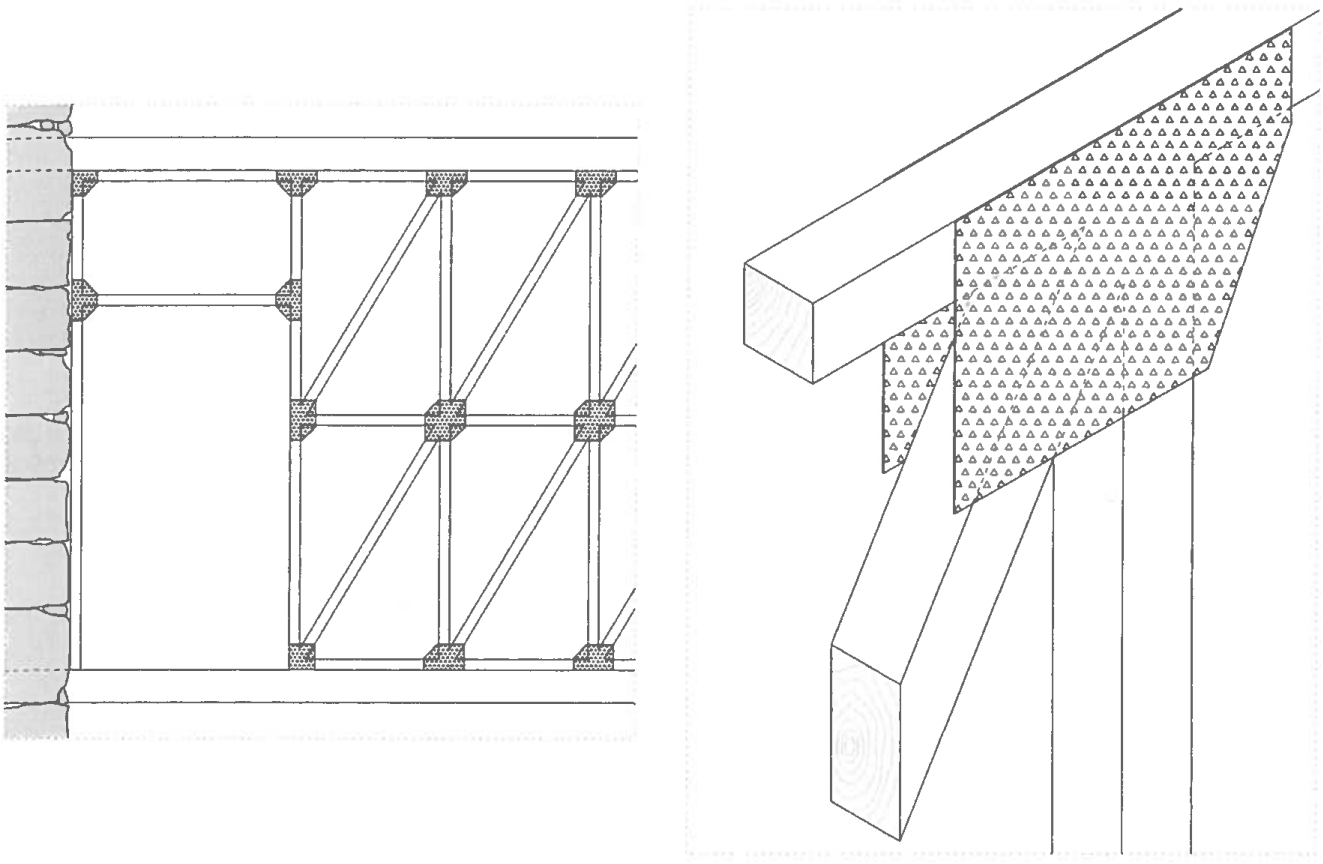


FIG. 10 Reinforcement of joints in the structure of a wooden wall.

— MINIMAL INTERVENTION ON FLOORS

Intervention on floors (*sobrados*)[3] is aimed at correcting their most frequent anomalies resulting from deterioration and deformation, but also from possible changes in use.

One of the most common anomalies of the structure of the floors is the rotting of the joints of their beams due to fungi or xylophagous insects. This problem is aggravated by the presence of rising dampness in the wall, whether from rainfall infiltration or from the soil itself.
In the most severe cases of degradations, the repair of this anomaly implies the replacement of the degraded area using prostheses made of wood, metal, resins or composite materials.

Low-intrusive structural strengthening can be done with wood when it is necessary to increase the mechanical characteristics of the beam section by increasing its resistant module; or else consider the application of carbon fibers by using carbon laminates adhered to the wood with epoxy resins, thus forming an external reinforcement.

3 Wood-framed floors covered with flooring.

The main anomaly of ceiling and floor coverings is the deterioration of their constituent elements, which can be aggravated by the presence of dampness or as a result of warping, natural wood thermal creep, settling, or overloading.

The repair of elements or areas affected by rot can include the removal of the coating and the replacement of degraded boards (as a result of fungi or insect attack) with new pieces of the same type of wood and with the same geometry. The entire unaffected area must be properly treated with a preservative product suitable for the type of biological agent involved in the degradation; and the new wood to be applied must be well dried to prevent the proliferation of unremoved insects.

The improvement of floors is intended to solve their main deficits in order to increase not only their fire resistance, but also their acoustic insulation (against airborne and percussive noises) and thermal insulation, as well as in cases where these elements are located at the separation of spaces with different climatization.

In the case of waterproof floors (exterior/interiors) the moisture -proofing capacity should also be increased. The improvement actions are not aimed only at the isolated improvement of each of the above-mentioned anomalies, and may encompass the whole set, depending on several factors, such as the conditions of the element in the context of the building (exterior, interior, first floor, etc.), mandatory requirements (of operation, comfort, health, etc.), and regulatory requirements.

In the case of floors with stucco ceilings, the low-performance solution is also the least intrusive and is carried out from the floor level. This option ensures that the characteristics of the existing dwelling are preserved, and is therefore the best suited to preserve its values, whether in the case of stuccoed ceilings with ornaments and paintings, or the floorboards themselves.

The intervention tasks include removing the floor and cleaning the structure, including repairing damaged parts and treating all accessible surfaces with a fireproofing product, as well as inserting a mineral wool blanket between the beams.

Before replacing the properly repaired and treated floor, the entire floor surface should be insulated with an acoustic cloth (FIG. 11). In the case of wood ceilings, the intervention can also be carried out from below, thus providing an alternative to the flooring, or doubling the effectiveness of the action. If the building is in a bad state of conservation or if a significant increase in acoustic performance is desired, the intervention will necessarily have to be more intrusive, which may lead to the loss of values.

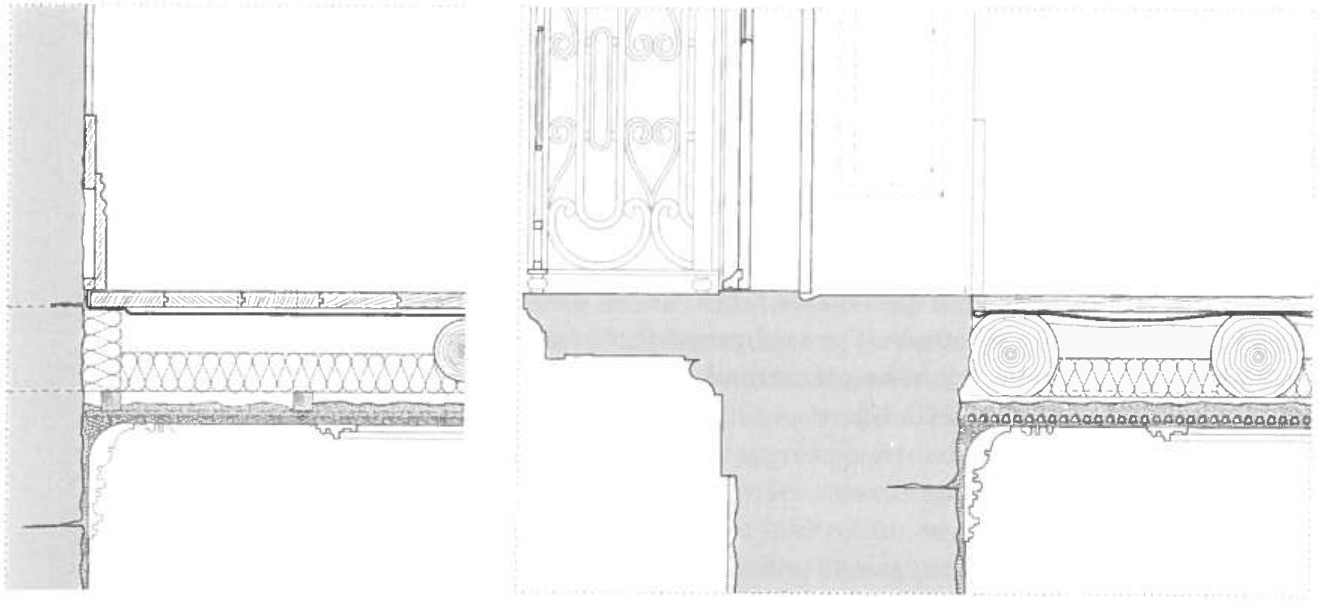


FIG. 11 Intervention on floors (*sobrados*).

— MINIMAL INTERVENTION ON ROOFS

Roofs are the most vulnerable element of the building shell due to their direct exposure to atmospheric agents. The roofs of houses in Porto are no exception, as they are only covered with ceramic tile, which does not provide any thermal insulation and is also somewhat vulnerable to watertightness. The existence of a paneling (*guarda-pó*)[4], although infrequent, can mitigate its performance.

Intervention on roofing should start by carefully observing its structure in order to identify damaged or deformed elements and then proceed to repair.

Similarly to what was previously mentioned about exterior walls and wooden floors, roof structure anomalies are mainly related to deformations of its elements as a result of wall settlements or the natural thermal creep of wood, which are aggravated by the presence of moisture. These anomalies also directly and significantly affect their coverings, both exterior (roof tiles) and interior (ceiling stucco). The main anomalies in roof coatings affect the tiles and sheets that make up the gutters and the drip edges.

Marseille roof tiles[5] are difficult to recover due to their composition and direct exposure to bad weather and they easily degrade over time. Therefore, the percentage of use of these elements after recovery is low, and their application on the slopes to be covered should be carefully managed. Due to the enormous risk of tiles breaking during roofing interventions, it is important to guarantee a significant stock of these elements for future maintenance actions.

Infiltration through the coating of gutters or drip edges can be due to ruptured joints or corrosion by oxidation of their sheets. In the case of zinc or lead sheets, these should be replaced or redone using the same

4 Plank cladding under ceramic tiles.
5 Flat roof tiles.

techniques and materials as the existing ones. In the case of galvanized iron sheets, it is advisable to replace them entirely with zinc or lead.

Actions to improve the performance of four and two-water roofs are aimed at solving their main deficits: increasing safety against fire propagation, increasing thermal and acoustic insulation, and increasing water and air tightness.

If the garret is not habitable, the simple and effective solution is to use mineral wool thermal insulation on the ceiling's mat slab, and to apply a waterproof and vapor-permeable fabric under the tiles, supported by the rafters and battens. The roof garret should act as an air gap and good ventilation should be guaranteed, either through appropriate tiles or other devices (FIG. 12).

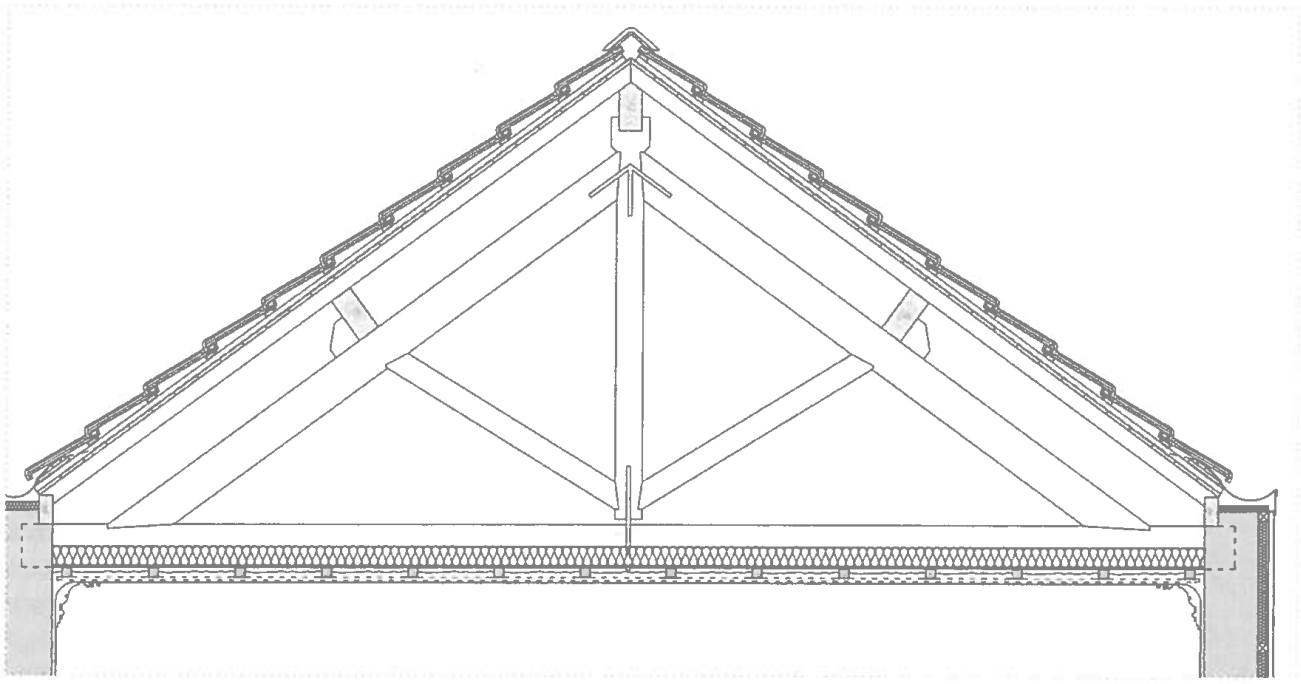


FIG. 12 Minimal intervention on roofs.

The options to be taken in the interventions on exterior frames should be carefully considered, especially when choosing the complete replacement by new frames, which should only occur as a last resort, when it is impossible to recover the existing frames and when it is demonstrated that this is the most economically viable solution and the one that best preserves the existing values.

Existing frames in buildings with heritage value should be preserved, since the preservation of genuine elements is a factor in the valuation of these properties. However, preservation begins with the regular maintenance of these elements, whose intrinsic characteristics and exposure to climatic aggressions tend to reduce their life span. The main causes of anomalies in exterior frames are the presence of humidity due to rainwater infiltration, which reaches all its parts and iron fittings; and use, including damage caused by vandalism.

A careful analysis of the frames should be performed prior to repairing deteriorated components, in order to identify and eliminate the causes of infiltrations, which can be: clogged channels, gaps, warping, iron fittings failure, etc. In cases of localized degradation, partial removal and replacement of components is an option if this task can be easily performed; otherwise, the components should be removed and replaced in their entirety with new ones of the same type of wood and geometry. In the case of attack by the dry-rot fungus, which is characterized by an enormous capacity of reproduction, all the elements of the frame should have a preventive treatment with fungicide.

As for painting, the use of traditional paints is preferred (oil paints were commonly used), but the use of products available on the market that offer better performance is also an option — for example, enamel paints — as long as their compatibility is guaranteed.

As for the doors, the basic solution is to apply sealants (neoprene and plush doorjamb profiles), associated with the collar frame and the doors, appropriate to the types of operation and the profile of the existing elements. Iron fittings should also be inspected and possibly new ones of more effective performance should be applied. If there is a glazed fanlight, the thickness of its glass should be increased or a double frame should be introduced (FIG. 13).

Regarding casement windows, flush and balcony windows, the solution is similar to that of doors and consists in the application of sealants and plush in the collar[6] of the stonework or frame leaves and in the revision of the iron fittings (FIG. 14). Although this is a more expensive solution, it nevertheless offers better performance; and as part of a minimal intervention, it is possible to insert a new frame from the inside of the gap, thus making it a double frame (FIG. 15).

It is important to note that the performance of exterior glazed frames cannot be assessed without also assessing shutters, which play a decisive role in both the heating and cooling seasons, provided they are used appropriately.

6 Profile made in the stonework to fix the frame and for it to strike.

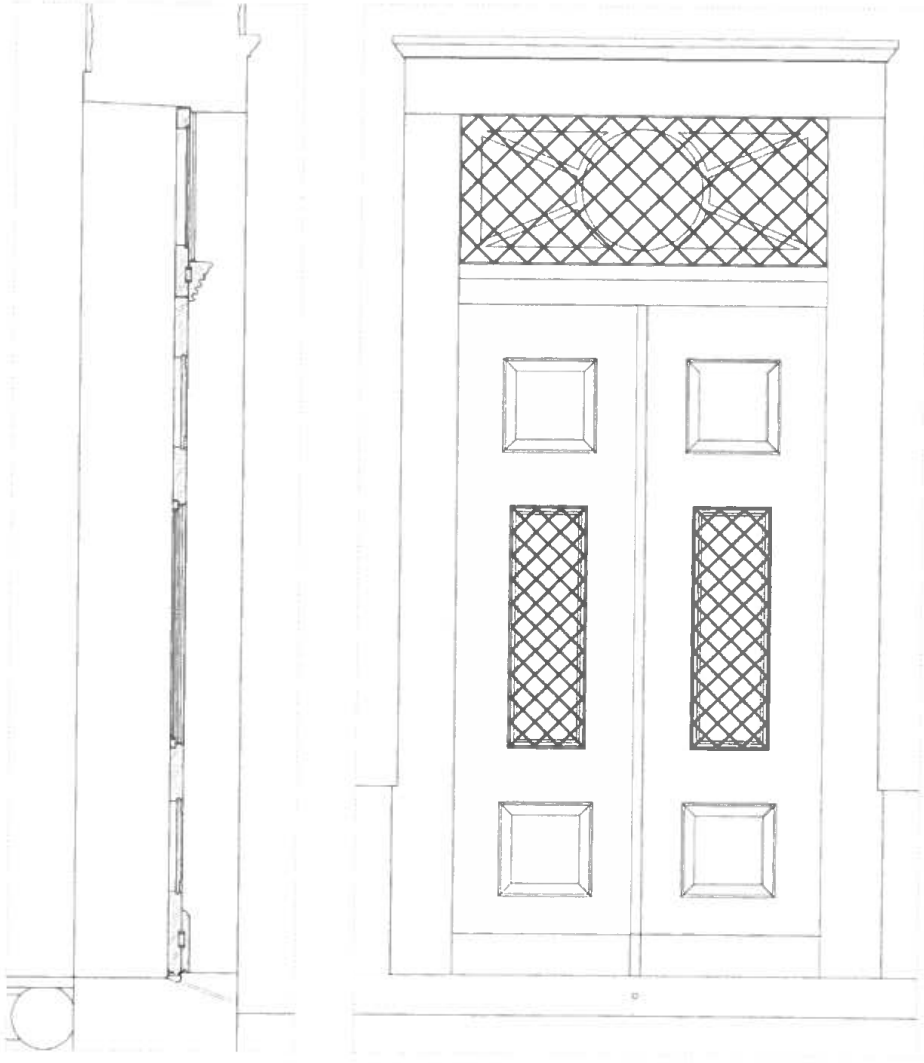
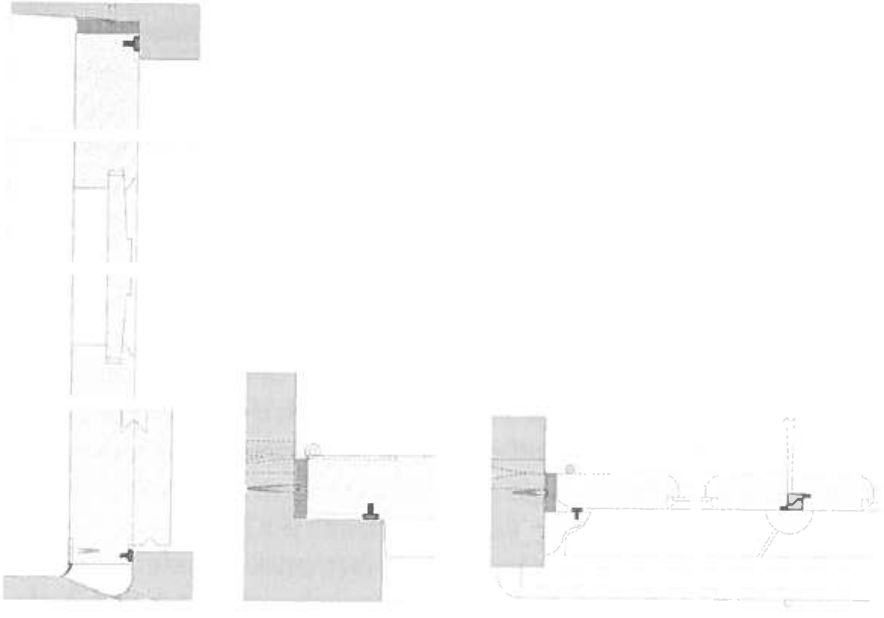


FIG. 13 Minimal intervention on doors.



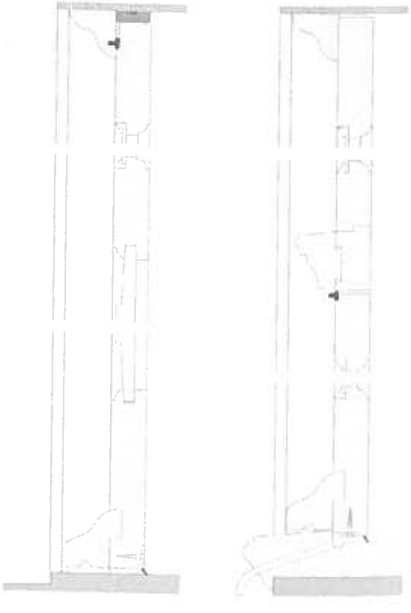


FIG. 14 Minimal intervention in casement balcony windows.

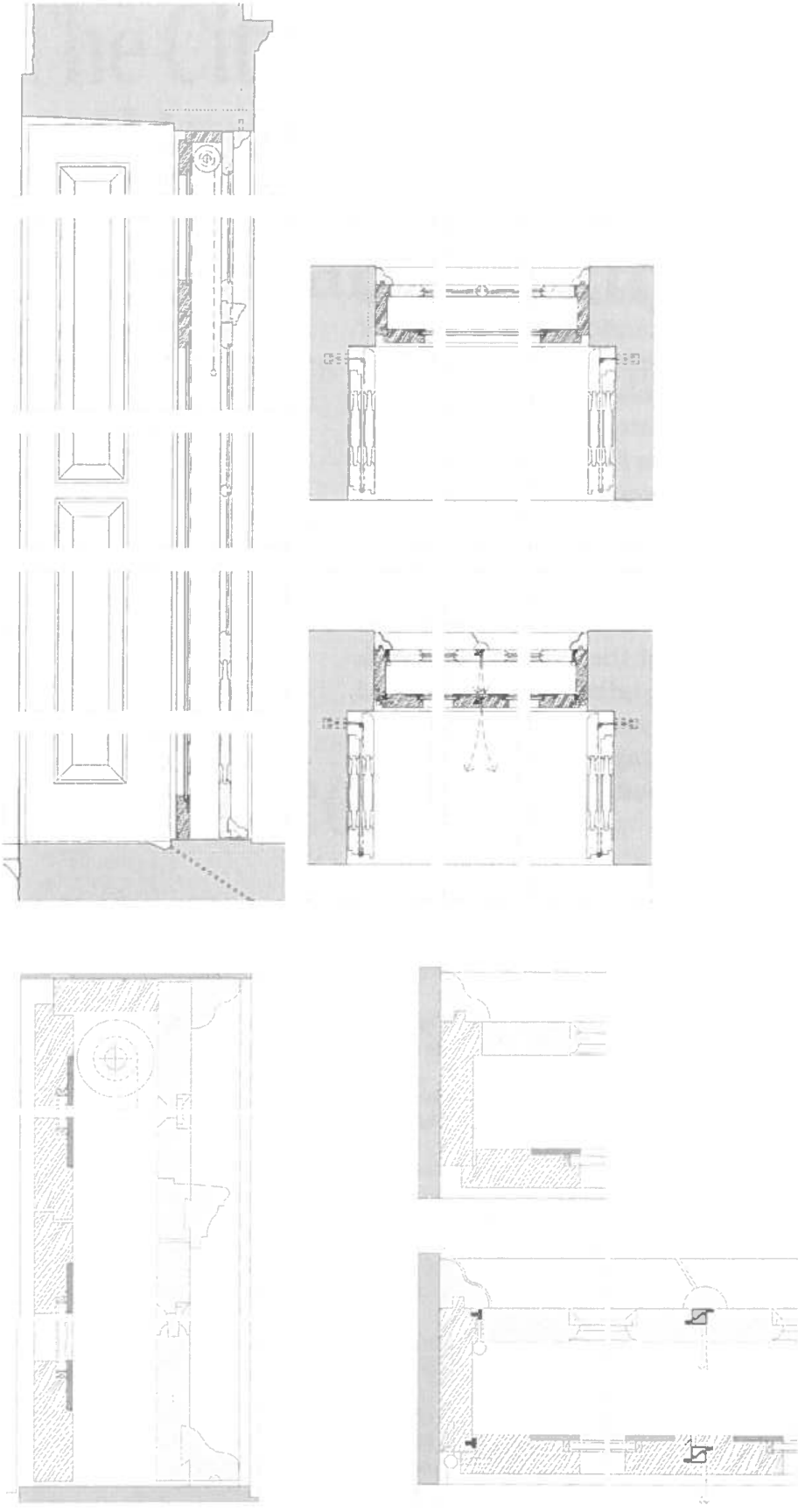


FIG. 15 Minimal intervention in casement balcony windows — introduction of double-frame.

CLOSING REMARKS

As the construction industry is one of the sectors with the greatest environmental impact, it makes perfect sense to invest in the conservation of historic centers as an environmentally sustainable option, thus reducing the consumption of natural resources and energy, the production of construction waste and allowing for better management of land occupation. As society is becoming more aware of the state of climate emergency in which we find ourselves, it is urgent to unmask the actions of new construction disguised as rehabilitation that are current practice in the historic city, opting for the extension of the useful life of buildings via their maintenance and a rehabilitation capable of preserving this historical legacy as an irreplaceable resource.

Current buildings represent the majority of the existing built environment and are an invaluable resource from an environmental point of view, deserving, therefore, to be properly rehabilitated and integrated into people's lives. In the case of historic buildings — the repository of our cultural identity — there is an added responsibility in their rehabilitation due to the importance of safeguarding their heritage values.

Far from advocating a museification of the historic city, this is rather a matter of allowing the city to be enjoyed by its inhabitants and to respond to their legitimate contemporary needs and claims, while respecting the material and immaterial heritages of our ancestors by keeping them alive and recovering the continuity that had been lost.

REFERENCES

Fernandes, F. B., 1999. *Transformação e Permanência na Habitação Portuense. As Formas da Casa na Forma da Cidade*. Porto: FAUP Publicações.

FERP, 2009. *Declaração de Viena. Um incentivo ao Património em Período de Recessão Económica*. Vienna.

Teixeira, J., 2014. *Salvaguarda e Valorização do Edificado Habitacional da Cidade Histórica. Metodologia de Intervenção no Sistema Construtivo da Casa Burguesa do Porto*. Ph. D. Thesis. Faculdade de Arquitectura da Universidade do Porto.

BIBLIOGRAPHY

Basto, A. de M., 1932. *O Pôrto do Romantismo*. Coimbra, Caminhos Romanos.

Berrance, L., 1992. *Evolução do Desenho das Fachadas das Habitações Correntes Almadinas 1774 - 1842*. Porto, Arquivo Histórico Municipal.

Ferrão, B., 1985. *Projecto e transformação urbana do Porto na época dos Almadas, 1758/1813*. Porto, FAUP Publicações.

Freitas, V. P. et al., 2012. *Manual de Apoio ao Projecto de Reabilitação de Edifícios Antigos*. Porto, Ordem dos Engenheiros da Região do Norte.

Mandroux-França, M. T. 1984. "Quatro fases de urbanização do Porto no século XVIII", In *Separata do Boletim Cultural da Câmara Municipal do Porto*, 2.ª série, vol.2. Porto.

Oliveira, E. V. de and Galhano, F., 1992. *Arquitectura Tradicional Portuguesa*. Lisboa, Etnográfica.

Peres, D. and Cruz, A., 1965. *História da Cidade do Porto*. Porto.

Ramos, L. de O., 1999. *História do Porto*. Porto, Porto.

Távora, F., 1969. *Estudo de renovação urbana do Barredo. Porto*. Porto.

Távora, F. et al., 1978. "Barredo: Operazione di rinnovo urbano", In *Lotus International*, 18, Milan. 95-99.

Teixeira, G. and Belém, M., 1998. *Diálogos de Edificação*. Porto, CRAT.

Teixeira, J. and Póvoas, R. F., 2010. "The Importance of Design in Porto's Ancient Buildings Interventions. Characterization of the Pathological Context through a Constructive Model", In *XII DBMC - Proceedings of the 12th Internacional Conference on Durability of Building Materials and Components*. Porto.