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Alice Tavares, Aníbal Costa & Humberto Varum

Civil Engineering Department, University of Aveiro, Aveiro, Portugal

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ADOBE AND MODERNISM IN ÍLHAVO, PORTUGAL

Alice Tavares, Aníbal Costa, and Humberto Varum
Civil Engineering Department, University of Aveiro, Aveiro, Portugal

The debate on the rehabilitation of adobe buildings and their heritage value leads to the inadequacies that still exist in the architectural characterization and conservation status of these buildings, especially outside large urban centers. This study seeks to contribute to this debate by focusing on adobe construction techniques in Ílhavo, Portugal, during the transition phase between vernacular and the architecture of the Modern Movement. The study also seeks to contribute to developing knowledge of the evolutionary process of adobe construction, associated with the appropriation and application of the new architectural language, by focusing on the period from the 1940s to the 1960s. Identified are the major defects associated with changes in construction methods. The data are intended to support the protection of this heritage. In Portugal, increasing importance is currently attributed to modernist buildings because they are focal points for the characterization of the country's architectural history. The preservation efforts for these buildings have encountered obstacles in terms of maintaining identity, given the recent interventions that were implemented. This conflict is seen, in a comprehensive manner, in the vernacular construction of adobe. However, knowledge of historical and cultural issues could even support projects in the tourism industry by valuing and preserving heritage.

KEY WORDS: modernist architecture, adobe, reinforced concrete, architectural languages

1. INTRODUCTION

The value of modernist and vernacular adobe buildings must be studied to gauge the level of consensus regarding their relevance as part of the evolution of architecture and as factors that provide links among various countries. The Modern Movement emerged in Europe as an expected evolution based on technological progress and the increasing desire for new forms of living spaces, considering that different scales—urban and interior—responded to a change in mentality related to the postwar period. The experimentation that developed with the introduction of new construction materials and the desire for change in architecture altered traditional metrics and the relationship between the interior and the exterior by allowing for greater visual and physical fluidity. Associated with this change, the introduction of reinforced concrete allowed not only for a break with construction constraints and the spaces of traditional construction, but also presented itself as a truly international technology because it could be adopted anywhere (Fernandez, 1988). This factor allowed for a chain of thought on a global scale, with countries such as Brazil, France, and the Netherlands, serving to influence Portuguese architecture.
The first half of the twentieth century was a period of great development due to the symbiosis between technological evolution and changes in ways of living and the concept of architectural space. In Portugal, political, social, and cultural circumstances brought nuances to the process of change, and this process took place in two phases. A preliminary phase to the introduction of the Modern Movement, which some authors (Tostões, 2002) distinguish as Modernism, extended into the 1940s. At this time, the number of architects was clearly insufficient for the demand. This insufficiency affected the implementation of new architecture in the country, with a predictable lack of uniformity in the use of architecture. Understanding the development of this process in Ílhavo (Figure 1), a distant village far from the large urban centers of Lisbon and Porto (yet with the advantage of being on the coast with solid maritime connections), is one of the aspects under consideration. The development of the construction methods and the identification of their different phases, based on the introduction of new materials, are also focal points. This study attempts to discern what techniques and languages were developed to introduce new materials and how they influenced traditional adobe construction techniques. This study also intends to assess whether the adoption of modernism is dependent on the introduction of reinforced concrete and, if so, to what degree.

Information was collected from the archives of the City Council of Ílhavo by consulting 240 licensing records for construction projects (CMI, 1943–60); books with records on construction projects and technical designs; minutes from council meetings; and documents supporting the Preliminary Urbanization Plan for Vila de Ílhavo. Data collection focused on the years from 1943 to 1960. In these archives, it was difficult to collect documented data prior to this date. For this reason, projects were also consulted from the Porcelain Factory of Vista Alegre (Ílhavo) as an important complement to the database because it contains information from the 1930s and 1940s. Collecting photographs and various data from site visits to locations and building interiors completed the process.

Figure 1. Ílhavo Geographic location of Ílhavo county—the study area (photo by Nuno Marques).
2. APPROPRIATION OF NEW ARCHITECTURAL LANGUAGES

As noted by the architect Ana Tostões (2002), “The architectural tradition has always meant the preservation of the essential characteristics resulting from the permanent habits of the people,” (p. 79). Accepting this premise, mechanisms were examined in this study that could simultaneously serve as engines for the appropriation of new languages of architecture and as the conditions that favored this change.

During the end of the 19th century and the beginning of the 20th century, the evolution of architectural languages in Ílhavo was associated with the search for contemporary methods in the private, industrial, maritime, and medical realms. It was a dynamic that, despite the distance from the large urban centers, sought to remain current at the cultural level and to use the services of architects (usually from Porto or Lisbon). Buildings designed by these professionals and engineering teams introduced construction and aesthetic innovations. Despite subsequent construction processes, these buildings mostly served as stylistic models for other technicians who repeated elements in civil construction. This repetition can be observed in Ílhavo during the Art Nouveau period of the 1910s and 1920s.

Even though this Art Nouveau influence took place in Ílhavo during the same period as for the rest of the country, it manifested later in Portugal compared with the rest of Europe. The inclusion of this architectural period in the region of study is necessary because it is during this phase that the first divergence with traditional architecture appeared, including implementing mechanisms relevant to the introduction of the Modern Movement in Ílhavo. Architecture was used as a social statement to necessitate change by demonstrating the cultural, architectural, and/or innovative methods produced in the rest of the country.

The Art Nouveau period can be considered the embryonic phase of a relationship/reaction in Europe to the Industrial Revolution. The established spatial enclosure concept was broken, with the introduction of iron and glass in construction, as in the Crystal Palace at the London Exhibition of 1851. This step was important toward changing existing spatial concepts. The 1900 Universal Exposition in Paris revealed the height of Art Nouveau in Paris, although its period of application would be short. The discussion surrounding the benefits of rapid technological change and the need for reasonable standards for the general population’s quality of life (Morris, 1992) began during the Art Nouveau period, and it continued during the Modernist Movement. During both periods, the urgency of architecture was not confined to the image of a luxury good, out of reach to ordinary citizens, even though it was risked being labeled as such.

As noted by Pevsner (1960), “Defending a deep social reform through art” (p. 81) emerges as the harbinger of “a way of manifesting the Modernist Movement” (Elia, 2001, p. 35). However, the production and construction processes of Art Nouveau, which required manufacturing strength and great design complexity, were ill adapted to industrial production and were removed from these objectives because of high costs. It was considered art because it used the representation of natural organic forms as its creative basis and claimed to escape the new mechanisms and their perceived lack of humanity, but it was not available to the general population and remained associated with the wealthy bourgeoisie.

Art Nouveau in Ílhavo emerged through private agents and through the construction of their homes (Figure 2). This emergence introduced innovations in relation to traditional construction methods (Figure 3) and the urban location of these buildings. However, the
existence of this artistic trend in the region, which comes with reasonable timeliness of the adoption of this trend in the capital (Lisbon), did not include the European developments. It was frequently limited to the design of main facades, with light/shade contrasts, a break in symmetry and regularity, the demarcation of the entrance of the building, and the introduction of stone sculptures with naturalist motifs. The finding that the construction material continued to be adobe blocks (sun-dried brick), despite the greater height of the construction projects (with an elevated basement and two floors), and that the internal organization was equally traditional confirms that the only adopted aspects were those that fit the social reality of the location. Just as observed later in the modernist phase, the approach is an escape from regular facade design and the use of light/dark contrasts in these buildings, but also, in many cases, the conservation of traditional interiors (Figure 4).

These aesthetic alterations conferred an image of being more culturally current and were regarded as cosmopolitan, which promoted the social status of their owners. This objective of individualizing the construction and creating a greater urban impact was reinforced by the frequent separation of these homes from the edge of the street. This placement permitted better contemplation of the building and also the symbolic separation of what was considered current.
The home had the main living area on a higher floor, freeing the raised basement for agricultural machinery, wine, or cellar space. This characteristic, the elevated position of the living area, in addition to its symbolic function, was later referred to in the first National Congress of Portuguese Architects (1948) in relation to the houses of Ílhavo because it introduced better conditions into a building’s living space. The permanent ventilation at the base of the walls prevented the adverse effects of ascending moisture and facilitated drying, while the timber floor increased the durability of the construction system (Ruano et al. 2010a). During this time, other innovations were also introduced, although the greater complexity of these designs proved to be an obstacle to broader influence. This could be seen in the facades and in roof support structures (Figure 2). The conditions were created for a greater acceptance of changes in traditional construction methods, which would be an important attitude for the emergence of the Modern Movement in Ílhavo.

In the 1930s and 1940s, new architectural methods were observed in Portugal that (Tostões, 2002) attempted to follow European architecture of the Modern Movement. However, a more global application of these architectural principles would emerge primarily in the 1950s with the more comprehensive availability of reinforced concrete as a resource. In this study, this material was adopted for the identification of an initial period to distinguish Modernism, as presented by the architect Ana Tostões (Tostões 2002), from the phase that preceded the Modern Movement and can be considered its embryonic phase.

2.1. The First Phase: Modernism

The emergence of a European influence through the Modern Movement and the growing debate on the approaches of Portuguese architects was exposed in the first Congress of Architects in 1948. At the national level, the duality of the aesthetic criteria of the project and the materials led, during the first half of the 20th century, to different
interpretations of architectural concepts and reflected the search for what could be considered the essence of Portuguese architecture, as opposed to architecture that followed the international trend.

In Portugal, the modernist phase lasted until the 1940s (Tostões, 2002). In Ílhavo, up to this period, construction methods, structural spaces, and aesthetic spaces were predominantly traditional, and changes emerged mostly after 1940. Until this time, the valued architectural approach was the one that was the best fit for the location and referenced regional architecture. This approach can be observed in one of the hubs of the old town—the Porcelain Factory of Vista Alegre (working-class neighborhood [Figure 5]) (Ruano et al. 2010b). This choice is corroborated in the temporary selection of associated architects, such as architect Raul Lino for the decoration of porcelain pieces or the architect António de Brito (professor of the Higher School for Fine Arts of Porto–ESBAP) for the urban and building settings (Vista Alegre Archive).

The overall concept for urban spaces and the buildings, which considered the quality of public space and the minimum conditions for housing, became one of the relevant guidelines for Modernist architects in Portugal. From Vista Alegre founding in 1824, these considerations, influenced by utopian and innovative European philosophies, (Ruano, 2009) existed at its manufacturing plant. The integration process of the factory, through the construction of buildings with various functions (i.e., theater, nursery, and museum), was always complemented by the creation of a natural landscape to confer a humanizing element in the industrial unit, provide employment, and improve local conditions (Ruano, 2009).

At the national level, the state sought to assert its influence over village and city centers in the 1940s by implementing urbanization plans (Fernandez, 1988) and introduced, through the urban architects it chose, a discussion on architecture and the Modernist Movement. In Ílhavo, these urbanists followed some guidelines that were in vogue at the time, such as zoning, concerns with the interior functionality of the blocks and their design, promoting tall housing buildings (to overcome the housing deficit), and conceptualizing public space for citizens to enjoy (Ruano, 2009).

This characteristic was revealed by the architect Keil do Amaral in a 1936 visit to the Netherlands. do Amaral saw the public involved in discussing new architectural solutions and possessing knowledge that he considered unusual (Tostões et al. 2010). This sense of civics, explicit in the considerations of the urban quality—where the buildings had to have a united function with public space and the integration of carefully “constructed” natural elements—reflected the supremacy of the concept of a common good.

In this sense, public space was not presented as a void left by construction or as a channel for movement, but rather as a space for the enjoyment of the inhabitants. The design of infrastructure with afforestation gives urban spaces a higher degree of

![Figure 5. Photograph of Housing from different development phases of the working neighborhood of the Porcelain Factory of Vista Alegre (photo by Alice Tavares).](image)
humanization. do Amaral described these aspects in “Modern Dutch Architecture” (1943) (Tostões and, 2010), where he reflected on the function of architects, who—in Portugal—still had problems with the public understanding their space for action. This line of thinking, which was based on a defense of public welfare, was defended by the architect Carlos Ramos (Director of the School of Fine Arts of Porto—ESBAP, Porto, where the architecture course of study was administered) in terms of a commitment inherent in the role of the architect with a social mission in a society that objectively respond to the programs (Fundação Calouste Gulbenkian [FCG], 1986).

Nationally, the debate centered on the need for architects to commit to improving the population’s quality of life and culture in general and to respecting local identity. These ideas were defended by architects Carlos Ramos and Keil do Amaral (Lisbon City Council) and later by Fernando Távora (ESBAP, Porto), among others, and were of great relevance in the discussions on architecture, urban qualifications, and housing conditions (FCG, 1986; Távora, 1947; Tostões et al. 2010).

This approach was reflected in Ílhavo in the implementation of the urbanization plans, which began in 1946 ( ) with architects Carlos Manuel Ramos (son of Carlos Ramos), José Fonseca y Llamedo (Spanish architect and contemporary assistant of the office of Carlos Ramos), and Samuel Quininha from Lisbon. These men were named by the government, through the Ministry of Public Works and Construction, and charged with the projects for the plans and their technical monitoring.

The implantation of urbanization plans in 1946 reflected the first attempts for an overall ordering of the center of Vila de Ílhavo and the areas with the greatest real estate/tourism pressure, such as the beaches of Costa Nova and Barra. New urban metrics were established that altered the lot sizing and the distances between buildings and their setbacks from public roads and took on new concerns with hygiene, comfort, salubrity, and sanitary concerns (whether urban spaces or housing units). The changes that took place were extensive and not always readily accepted or easily implemented, particularly in terms of facilitating public enjoyment inside of the blocks and accepting the idea of collective housing in an apartment block. This resistance by the residents of Ílhavo was due to the contrary changes the new measures brought to their way of life, with regards to the complexity of the social and economic networks of their environment. In one regard, the inside of the parks had accessory functions, either through rentals or with offices or gardens considered indispensible for the maintenance of the domestic economy. In another regard, the taste for individual housing was well entrenched, and in the 1950s, the single-family home was the predominantly licensed construction (Ruano, 2009).

The area’s land conditions favored buildings that were not very tall, which, together with good local raw materials for adobe construction, justified this tendency. In addition to the likely social protest, the measures recommended for the redefinition of the blocks of the village center were difficult to implement due to the economic burden this would place on the government, the City Council of Ílhavo (CMI, ). In this sense, the radical changes of new construction in the zones of the urbanization plans did not produce the predicted effect within the established amount of time.

The change in architectural design took hold gradually. In the first phase, as changes in spatial design were not assimilated, alterations were limited to the facade. The first sign was the introduction of platbands and the orthogonalization of openings. This element gave the main facade a sense of modernity.

Some spatial changes emerged due to legal obligations, namely conditions for lighting and ventilation, minimum standard dimensions, and the location of living spaces. Other
changes resulted from changes in society, as people began to desire spaces for socializing inside homes. During the 1940s and 1950s, this desire was seen through new interventions in room spaces, such as integrating living and dining functions. In existing buildings, this was achieved by demolishing dividing walls, creating defining arcs (Figure 6).

We found that the diversity of experiences that focused on the internal organization of housing in the working-class neighborhood of the Porcelain Factory of Vista Alegre (Ilhavo), was of little relevance in the center of Vila de Ilhavo until the 1940s because of the difficulty in accessing the services of architects (CMIc), a difficulty that did not exist for the factory because it belonged to a group with headquarters in Lisbon and companies in Porto. In the initial stage of Modernism, the desire for change was characterized by the adoption of aesthetic elements, particularly with regards to facade design, and, at a certain level, with regards to the new technology, which profoundly changed spatial concepts.

Throughout the 1940s, along with the introduction of reinforced concrete, there were several attempts at spatial and aesthetic changes. The use of reinforced concrete allowed for a greater interconnectedness of spaces, the placement of stairs as an aesthetic element that characterized the lounge or living room (without appearing confined), and the opening of large embrasures (Figure 7). However, even with the new experiences in organizing spaces, adobe blocks (sun-dried brick) remained a resource in a mixed system with reinforced concrete and a connection of metric spaces to traditional spaces. In the 1950s, the system was, in some cases, still mixed, but more luxurious uses of concrete could be observed, demonstrating the capabilities of the technique (Figure 8).
During the periods that lacked overall architectural design concepts, other professional classes adopted some of the stylistic elements and adapted them to the limitations of the traditional construction system. However, greater attention was often reserved for the design of the main facade, where new materials and technologies merged as an element of social affirmation, but without introducing changes at the spatial level. Facades with modernist elements could be observed in buildings with traditional internal organization. For this reason, despite the fact that these buildings were designed using modernist techniques and, in this sense, could not be considered vernacular, the break with the traditional system was not radical during the initial phase identified as modernist, which was the first stage in the implementation of the Modern Movement. The lack of architects was one of the factors that delayed the development of modernist architecture in Ilhavo.

Other technical agents adopted some architectural projects as models and repeated small alterations independent of the design. The adoption of models outside the original
framework, instead of responding to assumptions of local and natural integration, resulted in the loss of the buildings’ uniqueness. For this reason, areas peripheral to the centers are more susceptible to the loss of identity and, consequently, the majority of the future patrimonial heritage.

2.2. The Second Phase: The Modern Movement

The Modern Movement, as defined by Ana Tostões, can be understood as a full development in Portugal beginning in the 1950s (Tostões, 2002). The centers of Lisbon and Porto were two important poles of influence. New creative forms were sought, sometimes based on the relationship of metric proportions, which defined the characterizing elements of the space, its volume, and urban integration. New forms were suggested that used other materials in new structural and roof systems. Above all, the influence of the ceramic and cement industries in the 1950s and the peak of the development of housing construction in Ílhavo, would favor the substitution of adobe with ceramic brick. The introduction of the portico system of reinforced concrete, the use of brick slabs or slabs of reinforced concrete would be contemporary solutions during the Modern Movement.

In Ílhavo, through data collection on the provenance of professional designers who worked in this zone, the influence of the Porto School is relevant (Ruano, 2009). In Ílhavo, the adoption in 1946 of the first rules associated with the plans (Preliminary Plan for urbanization of the center of Vila de Ílhavo and the Urbanization Plan for Costa Nova Beach) would introduce a discussion on architecture with a clear incentive for adopting the trends of the Modern Movement. However, the urban architects involved, since they did not express opinions on the rejection of adobe blocks, would not be an obstacle to keeping this material. After acquiring land in Costa Nova, even the Lisbon architect Samuel Quininha designed his summer housing using adobe (1949–1958).

Once again, the social changes were slow processes. The concepts based on an open plan, large spaces, large embrasures, and large areas with glazing that characterized the Modern Movement, did not become common in Ílhavo. In this period, despite the desire for contemporaneity, there was a strong attachment to the land and its productive systems, which included adobe blocks. Recorded in the database is even a building from 1971 made of this material.

The respect for local identity and for the inherent construction processes would show that, even in 1960, the use of reinforced concrete for the portico was not common. In this regard, the examples of integrated buildings with this feature that were found appeared later, in the 1950s and 1960s, (Figure 9), which up until now had models in adobe blocks.

![Figure 9. Design of housing at Praia da Barra, 1958 (Architect Alfredo Ângelo de Magalhães) (Câmara Municipal de Ílhavo [CMI], 1943–1960).](image-url)
3. CHANGES IN CONSTRUCTION TRENDS IN THE 1940S AND 1950S IN ÍLHAVO

It appears that the construction that thrived in Ílhavo until the 1940s was based on traditional adobe construction. This construction was characterized by the use of load-bearing adobe walls (with thicknesses that, in this period, were approximately 0.35 m), a complementary structure of wood (mainly made of pine) for floors and roofs, the three-hole clay brick normally associated with wall areas at the base of windows, chimneys, pillars, and roofs with ceramic tiles (straw and/or Marseille).

Given the seasonal nature of adobe blocks production and the influence of the ceramic industries in the region, which are of considerable relevance here, the substitution of adobe with ceramic brick was observed and obeyed the same logic of structural functioning (Ruano et al. 2010a). That is, they were also simple load-bearing walls.

From the data collected for the period under study, it has been found in Ílhavo that there was a transitional phase in construction methods in which the traditional system was frequently complemented with elements of reinforced concrete (Figure 10), such as beams, balconies and overhangs with a reduced thickness, the use of pillars, solid slabs with a thickness of no more than 0.10 m, and the incorporation of reception areas, service areas (kitchens and bathrooms), and terraces. The adobe walls keep the main load-bearing function, and the reinforced concrete is introduced in elements complementing and improving the structural performance of the masonry system (Ruano, 2011b). The relation between traditional interior spaces and changes on the construction system was established and, gradually, were adapted to new architectural concerns, answering also to an old desire of breaking regular spatiality.

Reinforced concrete was introduced into the traditional adobe system to allow for the introduction of special elements that needed structural design. It was progressively adopted for specific situations, with the need to handle larger amplitudes and for thin slabs in the service areas (mainly on the first floor to overcome the previous problems of humidity where there were pinewood floors). The role of the aesthetic element occurred in the first phase and was restricted to facade design. The existence of licensing procedures has been noted only for the alteration of the facades (Figure 11), changing the traditional system and/or creating greater contrasts between light and shade produced by the use of reinforced concrete elements that marked entrance areas and the spans of the main facades.

Figure 10. Design of housing project from 1945: Mixed construction system made of adobe and reinforced concrete (first phase) (Câmara Municipal de Ílhavo [CMI], 1943–1960).
This study concludes that the 1940s were the period in which changes in construction began, on a large scale, to adopt the new material—reinforced concrete—to bridge some shortcomings found in the traditional adobe system. These alterations have been recorded mainly as a way to anchor the walls to match the support of the roof structure at the level of the lintels or at the base of the structure (Figure 12), introducing better cohesion and functioning of the whole with improvements in the mechanical behavior of the walls (Ruano et al. 2010a). In addition, these pieces also functioned as transitional elements (adobe/timber) to overcome the problem of cracking at the corners of the openings. It can also be observed that thin (0.10-m) solid slabs were introduced in rooms used for the bathroom and the kitchen, either for the brick slabs or for the concrete slabs, which were normally recessed. The initial phase of modernism began with this system. However, during this period (the 1940s and 1950s), there was also construction following the traditional model without the use of reinforced concrete slabs. This was a transition period for the architectural languages associated with the changes in construction methods. During this period, ceramic brick, which in the first phase replaced interior partition walls, would progressively take the place of adobe blocks because its application on exterior walls proved to be simple and resistant. Only during the latter part of the 1950s was the double brick wall used, once again, in the initial phase of introduction, as a load-bearing wall. This was during the implementation phase of the Modern Movement. The adoption of a concrete frame with curtain walls was later adopted in the 1960s (Ruano, 2011b), but only rarely with adobe blocks.
Another change in the traditional construction system was the disappearance of the airshaft for ventilation on the ground floor (made of timber) in favor of progressively adopting concrete and coating the hydraulic mosaic tile in the service and entrance areas. This feature, associated with the lack of systematization in the application of water cutoff walls, would help with rising moisture because the water table in this region is usually high (Figure 13).

In some cases, the use of cement mortar, normally used with brick walls, was also applied to adobe walls, which caused damage in the medium term due to the incompatibility of these materials (Figure 14). The cement mortar reaches its maximum strength in a very short time. But mortars based on lime progressively increase their strength, without suffering a significant strength decrease with age. Lime-based mortars with more than one thousand years are found with compression strength exceeding 200kg/cm² (Mellace et al. 2012).

Figure 13. Photographs of traditional house with ground-floor ventilation and the following one, without ventilation space at ground-floor with moisture damages (interior and exterior face of wall) (photos by Alice Tavares).

Figure 14. Photographs of damages in the plastering mortars (with disintegration or detachment) related to the application of cement mortar on adobe walls (photos by Alice Tavares).
Apart from the use of Portland cement renderings (external or internal), another defect frequently observed in existing adobe constructions is related to the application of non-permeable wall paints. The impermeable characteristic of these external layers in walls is mostly responsible to reduce the capacity of expulsion of moisture outwards, changing the natural balance that can be achieved with traditional mortars and paints. The lack of understanding of this phenomenon was one of the reasons the traditional technique was devalued, which is even noted by owners and builders today. The greater ease of using cement mortar, instead of lime mortar, led to a massive loss of locations where different types of lime were produced and led to the loss of traditional techniques, which complemented the use of adobe blocks. Marseille roofing and straw roofing supported by a timber structure as well as adobe blocks foundations were the last elements to disappear from construction methods.

4. MAIN PROBLEMS RESULTING FROM THE NEW ALTERATIONS

The most commonly reported problem in adobe constructions during this period is corrosion of the steel used in the reinforced concrete, mainly in the thin elements of the main facade, which is more subject to wear caused by vehicles, air pollution, and humidity (Figure 15). The discontinuation in the use of eaves and installed platbands in a building system susceptible to water (Figure 16) and the introduction of terraces with sealing problems were responsible for leaks and deficiencies in controlling the flow of rainwater.

During this period (1940s and 1950s), alterations were frequently made to the interiors of the residential buildings. The main objective was to broaden these spaces, in particular the connection between the living room and the dining room, and to remove the main hallway to improve illumination. However, the metric regularity of the spaces, which were confined in some cases by interior adobe walls, was compromised by the demolition of some interior load-bearing adobe walls. Therefore, the structural performance was affected, since the distribution of loads was changed, overloading the remaining walls. The effect of this can be seen through the cracks appearing in the walls and unevenness in the top floor.

The lack of spatial rigidity between walls and between the wall and the floor caused cracking, which increased damaged caused by water infiltrating through the cracks. The consequent rapid degradation of the plastering mortars ended up damaging the adobe

Figure 15. Photographs of damages on reinforced concrete slab (photos by Alice Tavares).
blocks. This problem is one of the most frequent and can be seen in the oldest buildings, which are not maintained and/or occupied (Ruano, 2011a).

The incompatibility of materials resulting from the introduction of cement mortar is an error frequently observed in the conservation processes. Not considered a problem, but rather a project/option deficiency, during the 1940s the substitution of adobe walls, with solid thermal and acoustic characteristics, with simple brick walls would lead to problems in adapting to local environmental conditions. This factor was the basis for the continuation of adobe techniques, given the worse conditions generated by the new solutions for thermal and acoustic comfort. Currently, insulating the roofing and the joinery should be considered mandatory to maintain constructed adobe.

5. CONCLUSIONS

The studied period is of great interest due to the diversity of social situations, architectural statements, construction methods in the transition phase, and the desire for contemporaneity. The finding that in the initial phase of the new architectural language of modernism the traditional adobe system was adapted to overcome its limits with more timely solutions indicates that the desire to change did not require the complete application of new materials (reinforced concrete). Similarly, it was found that the people of Ílhavo have a strong practical sense, a desire for autonomy in relation to the surroundings, and a concern for local production interests. These aspects are relevant to the longevity of the use of the traditional adobe construction system. In line with the orientation also argued by architects, in defense of the characteristics of the region of respecting identity with a strong link to local society, the Modern Movement was introduced late in Ílhavo. However, this period had some examples that are of municipal and regional interest, some of which still exist, as they are records that represent the evolution of architecture outside of the large centers.

The adoption of modernism was not dependent on the generalized application of reinforced concrete, given that spatial characteristics maintained a certain dimensional restraint, despite initial attempts to break the traditional metrics. It was mainly during this period that a greater number of mixed adobe and concrete constructions were found,
a period of testing and constructive change. However, some of the choices made soon revealed their damage potentiality. The most common damages are:

- Moisture problems in the walls base (exterior and interior faces of the walls), with direct impact in the health of the inhabitants, related to the elimination of the air shaft for ventilation on the ground floor, or to the inexistence of the water cut proof;
- Application of new elements on facades, like platbands, that associated with design errors may compromise the proper protection of exterior walls and roofs structures. The new solutions adopted in the mixed construction system (adobe / reinforced concrete) not always respected the old material (sun-dried brick));
- Structural problems connected to previous reconstruction processes intending to modernize ancient buildings—for example, demolition of load-bearing interior walls, breaking the spatial regularity and the unitary structural behaviour;
- Durability of the reinforced concrete elements—frequently is observed the decay of steel reinforcement that may cause a strength capacity reduction and have also aesthetic implications in the building image; and
- Incompatibility between materials (sun-dried brick and cement), which is a problem detected in Modernist buildings, but also in recent conservation’s interventions.

Given the understanding of its application to the contemporary demands of the period, the development of the new language of the Modern Movement did not adapt to traditional construction systems. In addition, the small number of architects in the country delayed its development and provided the time necessary for new productive industries associated with construction and the supply and use of resources during a period of greater need for construction to be superimposed on traditional methods. Given the seasonality of the production of adobe blocks and the lack of university training for use of this material, new architects moved away from this material, which led to the substitution of materials and building techniques.

Growing environmental awareness combined with the population’s capacity for decisions and civic interventions is leading to pressure on construction agents and research centers to create solutions that privilege sustainability. The adobe system has great advantages in terms of energy consumption in its construction, utilization, and demolition. These are strong arguments to further study the legacy left by traditional adobe construction to recognize its potential for reducing environmental impact.

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