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METHODOLOGY FOR THE CHARACTERIZATION OF BUILDING ENVELOPE: VIRGEN DEL CARMEN GROUP AT VALENCIA

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ABSTRACT

This communication is developed within the activities of the project funded by the Valencian Regional Government "The heritage consideration of the social Modern Movement's public housing. The Virgen del Carmen group, revitalization, and energetic updating (MOMOvivso). In this project, a Modern Movement heritage social housing research is proposed to progress in the preservation of this architecture. Accordingly, a methodological model is made and applied to Valencia's 614 housing estate, placed in the suburb zone named "El Cabañal". This residential complex was designed by the architects Fernando M. García-Ordóñez and Juan M. Dexeus Beatty, and it was built between 1958 and 1962. It was developed under the new social housing regulatory framework, which considers different configurations, as well as new constructive techniques, aimed at standardizing the quality of their systems and components and improving the dwelling's indoor comfort.
The present communication is a summary of the analysis process leading to ideation of a comprehensive methodology for the buildings envelope characterization which has been performed under the referred regulatory framework and applied to different types of buildings. For this purpose, three action lines have been proposed: analysis of documentation and contemporary regulations, an inspection report with the visits carried out, and the envelope non-destructive testing.

KEYWORDS

Constructive analysis; characterization; building envelope; social housing; the 1960s.

1. INTRODUCTION

1.1. Context

The Modern Movement for social housing is still considered one of the most important topics for contemporary architecture. The 20th century was the collective housing's intensive construction biggest period in Spain and Europe. Currently, the modern dwelling is consolidated as an important built heritage in the contemporary city. The analysis of each specific case will be crucial for its future valorisation and conservation (García Vazquez, 2016).
The research project from which this work arises aims to enhance the value of the

social housing of the Modern Movement in the Valencian Community, updating its habitability conditions and improving its social functionality. All this needs to be transmitted by raising awareness in society and involving the supervisory institutions responsible for heritage protection in order to guarantee the results of transfer. The "MOMOvivso" project proposes a research work applied to this heritage housing estate. The analysis will delve into the study of the Virgen del Carmen group as a model for systematizing the degradation processes. These will be systematically analysed by defining the constructive elements and identifying their associated pathology to develop an intervention strategies catalogue, always associated with the conservation of their heritage values.

The main aim of this communication is to share a methodological research process on aspects relating to the constructional characterization of the envelopes and their performance. An objective data collection that allows conclusions to be drawn that facilitate decision-making by technicians in conservation, updating and refurbishment actions. The data collection campaigns will be carried out throughout 2022 and 2023 in accordance with the objectives of the aforementioned project.

1.2. Field of study

The Virgen del Carmen's 614 dwellings were one of the first works of the "Obra Sindical del Hogar y la Arquitectura" (OSH) in Valencia, they were built between 1958 and 1962. They are placed next to the "Cabañal" old village's cemetery, and the trainway that connects Valencia and Barcelona. The project designers´ architects were Fernando Martínez García-Ordóñez and Juan Maria Dexeus Beatty (CSIC 1963), and the construction managers were the architect Vicente Valls Abda (OSH) and Mauro Lleó Serret (National Housing Institute, INV by its Spanish acronym). This new housing estate was placed in the "El Cabañal" area, configured by the old fishing settlement. It was the unique intervention made within the Flood Plan after the double Turia river flood, which flooded a large part of the city and left a large part of the population without housing and other facilities (Martínez-Marcos 2010).

The organizational structure used in the group design is unrelated to the near housing environment. Large urban open spaces and open edifications were built. For buildings, two types were designed: linear buildings of 4-5 floors, with a reinforced concrete outdoor seen structure, and two dwellings per stair landing. Furthermore, 2-5 floors towers, with bricks bearing walls, and three dwellings per stair landing (Fig. 1). Thus, housings had cross ventilation and an adequate geographical orientation to guarantee certain passive measures to generate indoor comfort (Jordá-Such 2009). Dwellings have a minimum extension, for 2, 3, or 4 bedrooms. A strong Central European functionalism connection is evidenced within its design, it is expressed in the use of both urbanistic and architectural criteria (Palomares-Figueres and Jordá-Such 2010). Independence between vehicles and pedestrian flow, construction of green and living areas between parallel buildings, façades shaped by large openings or terraces modulation, standardization and prefabrication of constructive systems and installations, flat roofs, and not ornamental finishes (Fig. 2).

The constructive systems applied, were the techniques reported by the OSH with the aim to get standardized and economically controlled constructive processes. These included some small products that were being produced in a huge volume by the national industry, so it allowed an industrial process without important economic investment. The whole group was partially refurbished in the 1980s, and more widely in the 1990s: structural aspects, roof accessibility, and façade lining were included.

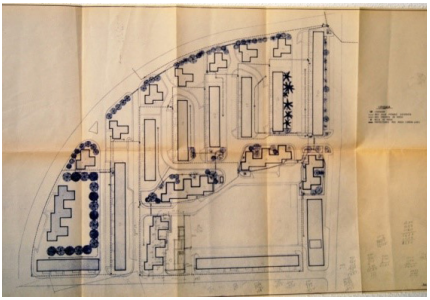

Figure 1. Location plan. Original Project (1958)). Source: (García-Ordoñez and Dexeus-Beatty 1958)

Figure 2. Construction works finish image. Source: (CSIC 1963)

1.3. Historical and regulatory framework

The Spanish National Housing Institute "Instituto Nacional de la Vivienda" (INV) and the OSH were political tools created in 1939, they aimed to promote the construction of social housing in a nationally organized manner (Salgado-Torres 1964).
In a first period (1939-1954) both were influenced by the economic and social aftermath of the recent Spanish Civil War. This beginning was characterized by a severe economic recession as well as important difficulties for the construction industry. The economic resources shortage, the limited industrial capacity and an almost non-existent social-housing legislation did not allow reaching the INV and OSH's main objectives in the first fifteen years. In spite of this, some new technologies alternatives and non-conventional method necessities are raised by the INV and OSH in 1949 (Sambricio 2004). The intensive housing construction takes off in a second and prolific period, between 1954-1964, along which more than 200.000 dwellings were constructed in Spain. Several factors bring about this substantial change. The new economic model change stated in the 1950s came together with a rural exodus to the cities. Two lines of action were developed by the Spanish Government to deal with this situation: on one hand, new social housing was promoted, involving private companies in the development. On the other hand, a new social housing regulatory legislation was created in 1954 (Organización Sindical del Hogar 1964).
A new specific legal framework was created for this new social housing constructive model. It began with the "Ley de Viviendas de Renta Limitada" (Limited Income Housing law) (BOE-A-1954-10883 1954) and its later regulatory implementation. The previous laws ("Ley de Viviendas Protegidas", 1939; y "Ley de Viviendas Bonificables", 1944) were repealed by this new regulation. Two new social housing models appear in this law: "Viviendas de Renta Limitada" (Limited Incoming housing), and "Viviendas subvencionadas" (subsidized housing). Public bodies like OSH, the "Instituto Nacional de Colonización (INC)" (National Colonization Institute) and other specifics agencies, must collaborate with the INV in this issue. Soon after, in July 1955, the "Ordenanzas Técnicas y Normas Constructivas" (Technical Ordinances and Building Regulations) are passed (BOE-A-1955-10121 1955). The basis of the development of buildings and energy standards are set by these ordinances, that were not technologically innovative but which aimed an immediate economy of resources and minimum healthiness (Delgado-Orusco 2003).

2. SOURCE DOCUMENTATION

The bibliographic search developed in this work is based on three main lines of research: General bibliographic on the construction method of the period, papers and others more specific publications about the field of study, and finally, the technic documentation made by the architects for the construction works.

The research documentary team has found the followings project on this housing estate:

- 142-Housing Project. Virgen del Carmen Group. Phase 1. 1958
- 90-Housing Project and 232-housing and urban project. Virgen del Carmen Group. Phase 2. 1958
- Additional Foundations Project for phases 1 and 2. 1962. This modified project introduces a change over the two previous. It modifies the foundation structural system, of both the concrete and the buildings´ bearing walls (Fig. 3).
- Structural Repair Project of the Virgen del Carmen Group of Valencia. 1986. This project focuses on the repair of the external structure of the linear building. After identifying a concrete carbonation process, cleaning and protection were carried out over the affected areas.
- Refurbishment and Structural Repair Project, Virgen del Carmen Group. 1994. The reparation of the internal structure, affected by a concrete aluminous process, is the focus of this project. Water supply installation, sanitation system, a new façade lining, and metal louvres' restoration, are other items included in this project. Important structural reinforces were made by implementing new steel beams under the original slab, which needed a new ceiling, which reduces the clear height. New works to improve the accessibility and the healthiness of housing were included in the subsequent modified project. Thus, new building accesses, new waterproofing and new stairs to the roof were made.
- Urban Project Virgen del Carmen Group. 1994. In parallel with the building refurbishment, a deeply urban transformation is carried out. Renovation of urban infrastructure, new urban layouts, paving and a complete gardener project are included in this actuation.

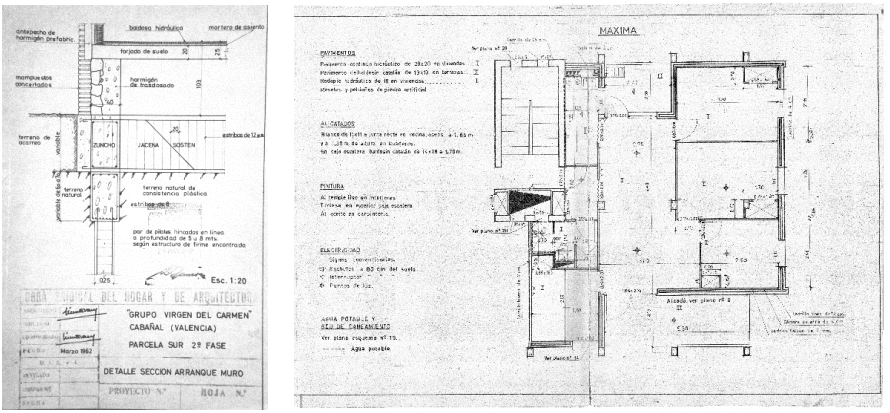

Figure 3. Constructive section and plan with finishing technical specifications, original Project. 1962

3. VISITS AND BUILDINGS PATHOLOGY REPORTS

The technical building ocular inspections and surveys are crucial to reach a correct diagnosis of the analysed items (Galán, 2020). It begins with some elements and field constructive system selection for the inspection. Several visits at different times in the year with different objectives have been scheduled to the housing estate by the research group. General visits, two specific-buildings visits in two different types of them (Fig. 4), or indoor dwelling visits, will be made.

Three inspection checklist models will be made in each stage of the process for the diagnosis work. These inspection checklists will be customized for each selected case of study.

- Information and previous data checklist. These checklists summarize and organize the documental data. This information is only checkable during the inspection stage.
- Data acquisition. Building pathology and damage survey and tests. The data collection aims is to define the building´s current state, the presence or absence of defects and/or injuries and to collect all the necessary data for the correct assessment to be made in the conclusions. In addition, it also pursues to define the real geometric characteristics and to complete the definition voids in previous stages. To this end, criteria of the "ITE" (Technical Buildings Inspection) handbook, and Spanish standards like UNE 41805-9 (Roofs), UNE 41805-10 (Envelopes) UNE 41805-11 (windows), will be followed.
- Diagnosis and conclusions. Within the carried out technical inspection, the most relevant problems and their causes can be concluded, as well as the possible improvement proposals.

4. NON-DESTRUCTIVE TEST

4.1.Thermography

Thermography is a non-destructive test that allows to examination of the infrared radiation of the electromagnetic spectrum. The main infrared radiation source is heat or thermal radiation. It is a useful tool to make an energetic diagnostic, as several constructive defects, thermal bridges, insulation defects, or hidden water leaks can be easily and efficiently detected. It provides useful information to make son- located reparations. The equipment specifications are shown in Figure 5.

Figure 5. Scheme of quantification methodology. Source: (Robiel Manzueta 2022)

Thermographic Camera		
Model	Flir T420bx	
Accuracy	< 0.045ºC	
Display Resolution	320 x 240 px Ultramax ® 640 x 480 px	
Thermohydrometer		
Model	Extech MO297	

Figure 5. Thermographic report equipment

4.2. Windows inspection. Glasses thickness

A glasses' thickness measurement equip model Bohle, Merlin Laser (Fig.6) will be used to assess the houses' windows. This tool includes a laser diode with highly accurate electronic measurement. Simple glass, laminated, bulletproof, fireproof, multi-laminated, or double glazing units can be measured by this device. Also, both glasses and air space between thickness can be measured.

This test provides not only thickness measurements, but also it allows for checking the thermal transmittance as well as the energy efficiency of the envelope, an important input when an energetic simulation is carried out.

4.3. Transmittance assessment

Three phases have been defined for the transmittance assessment:

- Theoretical approach with eCondensa2 software (Fig 8).
- In-situ testing with a portable device, model Testo 435 (Fig. 7). This test provides an indirect measure of the envelope transmittance values. For this purpose, a wireless external temperature probe takes the outdoor temperature values. While another internal probe with four sensors is collecting data, three of them are collecting the wall temperature data, and the last one catches the indoor temperature. All

Figure 6. Glass thickness measure using Bohle, Merlin Laser device

of this is to obtain the wall temperature transmittance.

- Comparison of data obtained with the required parameter by the construction time regulations. This allows us to know the constructive system obsolescence degree, and to consider possible improvement interventions.

Figure 7. Thermal transmittance measure device, model Testo 435

4.4. Public space thermal analysis.

The cities' growth, caused by economic and demographic factors, determines noticeable urban environment transformations. Microclimatic noticeable differences are generated in the cities by these transformations. From the environmental point of view, not only in a landscape sense but climatic, these differences influence the citizens, flora and wildlife environment comfort conditions (Li 2016). Therefore, the urban areas and the external buildings' environment analysis are crucial in the whole study of the housing estate. An aero-thermographic survey is proposed within the urban assessment methodology, and a drone flight over the Valencian studied urban area is envisaged. This flight aims are to determine how the urban morphology, the paving or the vegetation design can influence the Urban Heat Island (UHI) phenome behaviour (Enteria, Santamouris, and Eicker 2021).

Two study areas are analysed, as comparisons between two different urban typologies and their effects on the public spaces of thermal flows can be made. Each area is subdivided into several smaller sectors, so they are easier to be analysed during the flights (Fig.9). The late afternoon is the best time for the data collecting, as it is possible to obtain them after the whole day of sun radiation, avoiding the direct sunny radiation distortions.

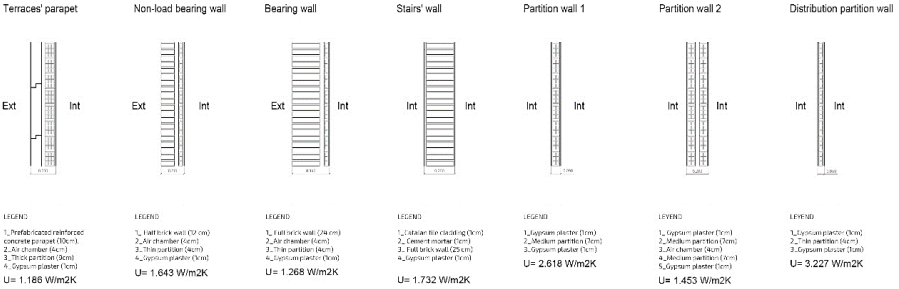

Figure 8. Thermal transmittance values obtained by the simulation software for the existing constructive system

The time flight in every area is 30 minutes approximately. The used drone is a DJI Matrice 210 (S/N: 0G0DE7R0P30017), equipped with an impact energy limiter (parachute), as is required by the urban flight legislation.

Figure 9. The two study areas for the aero-thermographic survey. Source: www.google.es/maps

5. PLANIMETRIC SURVEY AND FINAL DIAGNOSIS

A planimetric survey of plans, elevations and constructive sections will be made based on the previous data collected. The documental analysis, technical inspection and test results will be implemented for this purpose. These plans will represent four stages: initial project status, end-of-built status, current status and improvement modification status. The building pathology and historical modifications observed during the survey will be identified (Fig. 10). This allows to determine a case study graphic constructive evolution, from its beginning to nowadays. Therefore, a new refurbishment and improvement stage could be proposed.

Figure 10. Example of the planimetric survey made of the previous and the current status. Pathologies and modifications are shown. Linear building

6. CONCLUSIONS

In order to ensure social and cultural identity, the built heritage must be properly preserved and transmitted from one generation to the next. Holistic and cross-cutting planning is necessary for the study, treatment and protection of modern built heritage. Precise criteria for historical architecture and social protection are necessary, as well as several repairs and current quality construction and comfort standards updates. Therefore, a coordinated point of view is necessary. In addition, documentation of the analysis of each case study will be crucial to establish databases that will allow future enhancement and conservation approaches.

A planned methodology with technical inspections, surveys and NDT, all compatible with the habitability of the dwelling, is essential for the correct constructive diagnosis of these types. Consequently, the data collections have to be focused on both the constructive characterization and their healthy, thermal comfort and energetic implications.

Hence, a historical evolution timeline is required, and data cross with the originally designed and the final building, as well as to record the transformations suffered by the case study and how they have affected the current status. A progressive study that considers the different stages of the built material and its transformations: project status, construction phase, and current status. In this way, it will be possible to integrate an improvement proposal integrated in this evolutionary line with a continuity character.

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