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Heritage value combined with energy and sustainable retrofit: representative types of old Walloon dwellings built before 1914

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Abstract

Energy and sustainable retrofit of old buildings with heritage value is a challenging issue for Europe. The research project "P-RENEWAL" aims to develop a methodological tool for energy and sustainable retrofit of Walloon dwellings built before 1914, with heritage value. The present contribution will mainly discuss the methodology used to identify building typology and will also submit a detailed description of several building types. This methodology can be applied in other contexts to provide any user with data on different scales, from the building to the entire city, helping to make sustainable decisions.

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Keywords: patrimonial value; retrofit; sustainable architecture; architectural strategy interventions; building types

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1. Introduction

Energy and sustainable retrofit of old buildings with heritage value is a challenging issue for Europe. Indeed, "The Energy Efficiency Directive (2012/27/EU)" requires the establishment of a long-term strategy for mobilizing investment in the renovation of the national stock of residential and commercial buildings. Besides the European requirements, a "sustainable" society cannot build itself without respect for its past, but it also has to anchor in the present and assure a possible future. This is why built heritage must be conserved and transmitted to future generations. This conservation and transmission implies restoration, retrofitting, rehabilitation and maintenance of the built heritage. Conserving built heritage does not mean freezing it because opposition to progress would condemn it not to meet present and future needs, in terms of use as well as comfort and performances.

In the Walloon context, the old dwellings represent more than 25% of the dwelling stock. They give to Wallonia its identity and its architectural and historical legacy but also a real added value from an economic and tourist point of view. But this old dwellings stock has special characteristics: (1) singular thermal behavior characterized by a high thermal inertia; (2) specific materials and assemblies; (3) limited techniques or systems. So, an energy intervention generally has a significant impact on the balance of that type of building. It is a question of protecting the integrity of heritage values. This is the objective of the research project "P-RENEWAL". It aims to develop a methodological retrofitting tool for historical Walloon dwellings built before 1914 [1] in order to enhance heritage value and to combine it with relevant energy and environmental performances. The originality of this research is to consider energy, environmental and heritage aspects in a complementary way, in order to help designers to reach their objective of a greater sustainability.

The present contribution submits the methodology to identify dwelling typology (built before 1914) and a detailed description of several building types and their spatial distribution on the Walloon territory.

2. Historical research

This historical study focuses mainly on morphology, demography, urban and rural development, economy and types of dwelling. Historical urban and rural development of regions or countries has influenced economic activities and lifestyle. The economic activities and lifestyle had impacts on building systems and construction materials.

Wallonia, as it is today, was formed mainly during the last two centuries. But some key elements are older. There are, as an example, topographic or hydrographic elements that were at the origin of development of the city. Indeed, waterways and later railways allow an easier transport of people and food. Therefore, several cities (Mons, Charleroi, Namur, and Liège) developed around the furrow "Sambre-Meuse" (Fig. 1).

From the 10th century and especially in the 12th century, some key areas of dwellings developed more than others and became cities of thousands of inhabitants. However, most Walloon cities were and still are rural villages. On the landscaping plan, the city is outstanding in several aspects: (1) city walls, (2) mass of built, (3) dominant common ownership of housing, (4) the organization in streets and in squares as well as the quantity of infrastructure and their scale (towers, doors, fortifications, churches, halls, city hall, fountains, bridges, mills). [2]

In Wallonia, until the middle of the 19th century, life is essentially rural, in connection with soil resources. Farm families form the majority of the population. Their houses are small and low. Initially built as a single cell, they are further divided into several parts, and made with local easy-to-work materials. Generally, walls consist of wooden frames, on a stone base, filled with panels of cob, according to the half-timbered construction technique. The roof is in thatch. Very gradually, over centuries and generations, according to the necessities of life based on the agricultural work, this precarious housing is improved, enlarged, transformed. Mediocre for a long time, the income of the population allows the solidification and the use of the stone (or of the brick) only late [2].

Upon its independence, in 1830, Belgium with Brussels as capital, took part in the Industrial Revolution. Wallonia stood out as the continental cradle of the Industrial Revolution. In proportion to its population and surface, it occupied the second world place of the industrial nations, behind England, between 1810 and 1880. Between 1900 and 1910, Belgium was in the third position behind the United States and the United Kingdom [4]. At that time, around the furrow "Sambre-Meuse", cities got rich because of coal.

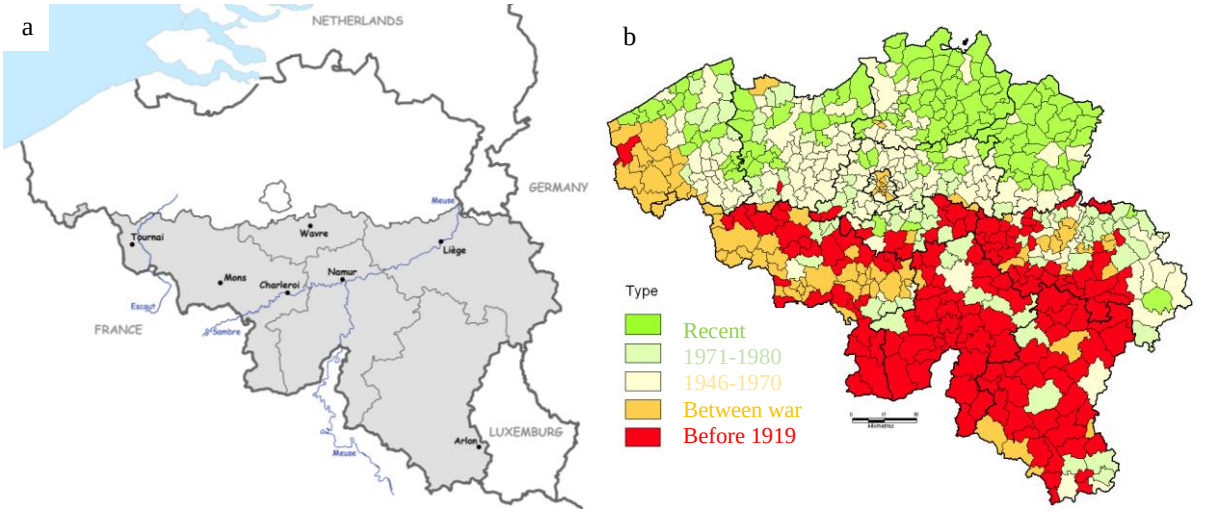

Fig. 1. (a) Map of Wallonia in context; (b) Space distribution of housing according to their period of construction in Belgium [3]

The architecture before 1890 was rather homogeneous. We can deduct the geology of the country by aspect of its monuments. Wallonia can be divided into four zones (Fig. 2) according to their land resources and climate. Those four zones influenced the socio-economic status of inhabitants but also the dwelling typology.

- North of the furrow Sambre-Meuse. This "silty" region proposes a wide range of materials: silt, bricks, tiles and stone. It also offered big fertile areas and temperate climate. This region was mainly occupied by the Church and of rich farmers.
- South of the furrow Sambre-Meuse. This "condrusienne" region proposes big variety of rocks and stones. It also offered little disruptive climate and calcareous soil that allow a good agriculture. This region was mainly occupied by noble families.
- Center of Wallonia, the "Ardenne", region with lowest income and resources. It offered mediocre ground and harsh climate that limited farming.
- "Belgian Lorraine" in the South of Ardenne. It offered fertile areas and adapted climate for farming.

The 19th century marked the beginning of big changes. Transportation modified the local and geologic authenticity of the architecture [4]. The first factors behind these transformations were connected to the emergence of a new economy: the industry, essentially Walloon [2]. New living districts became established little by little, near the urban cities. Those districts were mainly constituted by labor houses, small houses of two spans and two levels. The historic study highlighted the urban development of furrow Sambre-Meuse, the rest being rural.

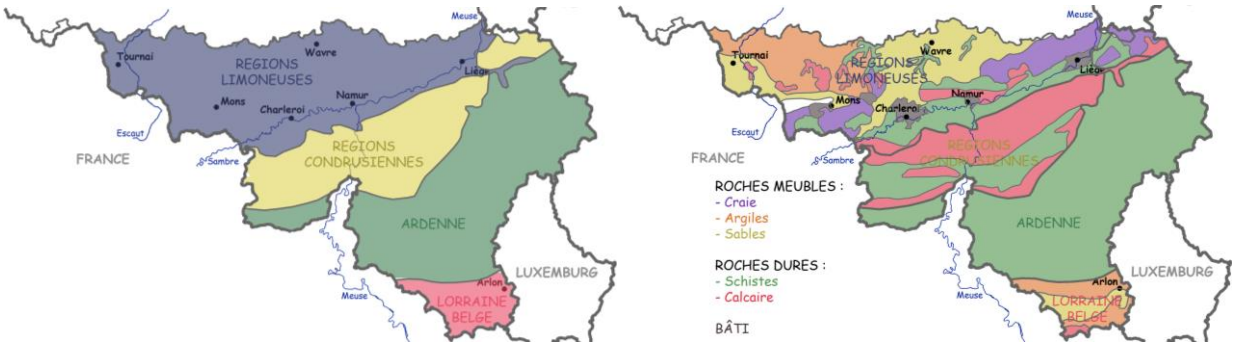

Fig. 2. (a) Map of four territorial areas; (b) Map of natural conditions of Wallonia [5]

3. Definition of dwelling typology

The dwelling typology before 1914 has been studied from the late 17th century because dwellings built before 1700 were mainly wooden buildings and were almost destroyed. Dwelling types were defined according to the historical research of Wallonia urban development but also to the changes in lifestyle of Walloons as well as changes in construction methods and materials used. Two main periods of urban development have been identified, even if dates vary a little in function of geographical zones:

- From 1700 to 1815: As the transport was difficult, the used materials were the ones found on the spot.
- From 1815 to 1914: After the Industrial Revolution, transportation facilities allow exchanges of materials and new techniques.

Based on archival and/or historical documents, each type of dwelling has been studied according to the methodology including a general description of the type (description of dwelling situation, spatial organization, internal circulation and stair case, building systems and materials, roof, façades and building materials), a description of the main characteristics (relation with public space, size of the plot, size of the building, volume, number of floors, presence of annex, height and width of the main façade…) and description of type variations if they exist. This analysis is based on two researches carried out by "Architecture et Climat": "B^3 RetroTool"[6] and the research on types of dwellings from Caroline Kints [7].

3.1. Urban dwelling typology

The single family row house is the most common form of dwelling in the cities of Wallonia until 1914. During this period, there are three main types of dwelling: the "maison bourgeoise", the modest or worker house, and the "hôtel de maître". These types are the evolution of the Walloon wooden row house and are thus characterized by the same spatial organization, construction principles and materials.

Spatial organization. (Fig.3) It reflects the lifestyle of the bourgeoisie in the 19th century and is organized in three modes: reception, family spaces and services or domestic spaces. Internal spaces are divided into two parts: a main part including the reception and living spaces and a secondary part, narrower, including services, stairs and corridors. The plan is organized with a succession of two or three rooms with a depth of 4 to 4.5 meters. Reception and living spaces have high ceilings, large width and are largely lit.

Construction system, principles and materials. The construction system is mainly governed by the rules of protection against urban fire. It is based on the constructive system of the Walloon wooden row house. Party walls are made of locally sourced brick and are not structural. The wooden floors are perpendicular to the street facades and partition walls. The wooden beams are spaced between 35 and 40 cm. The thickness of the bearing brick walls is also codified by the regulations of buildings to ensure stability. It varies between 28 cm and 48 cm depending on the type and height of walls. Recovery of floor charges and load-bearing walls is ensured by a combination of discharge vaults and metal lintels scattered throughout the façade and load-bearing walls. Only the structure of the roof is based on party walls, wooden beams ranging from wall to wall. The floors of the ground floor are partly made of hard materials. They are tiled or covered with marble. Floors of the upper levels are in wood. The ground cellars are usually performed in clay.

The two façades are narrow (6 m) and high (12 to 18m), however there is a big difference in composition between the two. Back cover: brick facade, sober and coated. Only a few metal lintels and sills are apparent. Main façade composition depends on different styles: neoclassical, eclectic… Materials used are brick, natural stone and oak for window frames. The level of the street façade decoration shows the social level of inhabitants.

Dwelling type variations. The type "maison bourgeoise" could be divided into three variations according to the construction date. Those three variations have the same spatial organization and the same internal plan but show variations at the level of the ground floor and stairs installation.

The same construction systems and materials are found in the modest house and in the "hôtel de maître". Only the location, the size of the plot, the width of the main façade, the surface area, the number of floors, the appearance of the street façade and interior finishes are different. Modest or worker row houses were mostly located in the popular and industrial districts. "Maisons bourgeoises" were located in developed cities. "Hôtels de maître" built for the upper bourgeoisie and aristocracy after 1830, were located along large avenues.

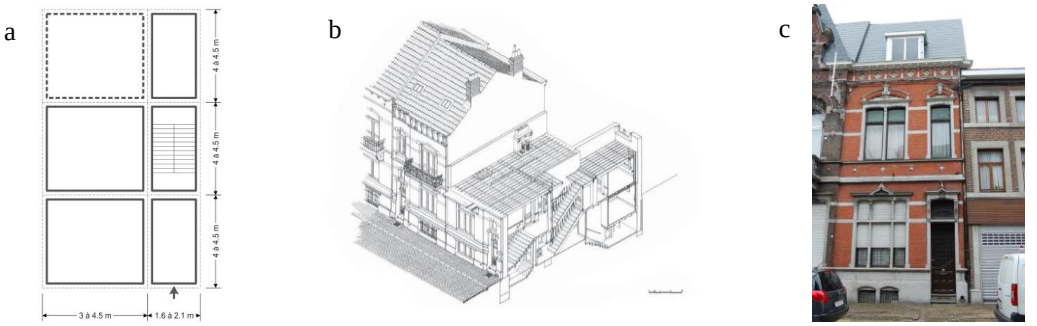

Fig. 3. (a) Spatial organization; (b) Construction principles of the “maison bourgeoise”; (c) Example

3.2. Rural dwelling typology [8]

Until the early 19th, the characteristics of this rural housing are very different from region to region: the use of local materials, the shape of the construction, the organization of buildings and the grouping of houses.

That participates in the production of much typified regional landscapes. Differences of materials and tones reflect largely the variety of rocks, remarkable on the scale of this small territory.

Spatial organization. Two situations in the rural constructions are distinguished: on one side, the powerful groups established by the seigneurial and abbatial farms and on the other one, the discreet small farms with disorganized buildings and poor tiny houses. For the modest construction, there are three main types of dwelling: the worker’s dwelling; the “farm in block” and the “lengthwise farm”. The worker’s dwelling is very basic, it is only one room and an attic for mainly seasonal workers, often constructed of local stone (rarely in bricks) with roofs covered with artificial slate. The “farm in block” and the “lengthwise farm” are the same spatial organization but size changes. These farms on one or two maximum levels are divided in three parts to welcome the family life, beasts and crops. The used material is local stone for all the house or only a part. For the prosperous construction, there are two main types of dwelling: the “farm with parallel buildings” and the “fortified square farm”. The “farm with parallel buildings” has a building dedicated to the family lives and another for the stable. The materials still local but much richer: limestone, marble and oak. Subsequently, several farms will be in bricks. Facades are in limestone, sandstone or in bricks and limestone. The decoration has an important place. The “fortified square farm” is a quadrilateral fully closed (an alternative is the farmhouse in U) which looks out onto a courtyard. Each section is specifically dedicated: sheepfold, one or several barns, stables and the home.

Construction system, principles and materials.

At the beginning and until 1830, buildings of wood-frame construction or stucco on the frame (with or without filling in the cob) are prevalent. Often, frames of the windows are in limestone. In function of the underground, we found different natural local stone buildings: limestone, granite, schist or sandstone. Later, solid walls of bricks are built.

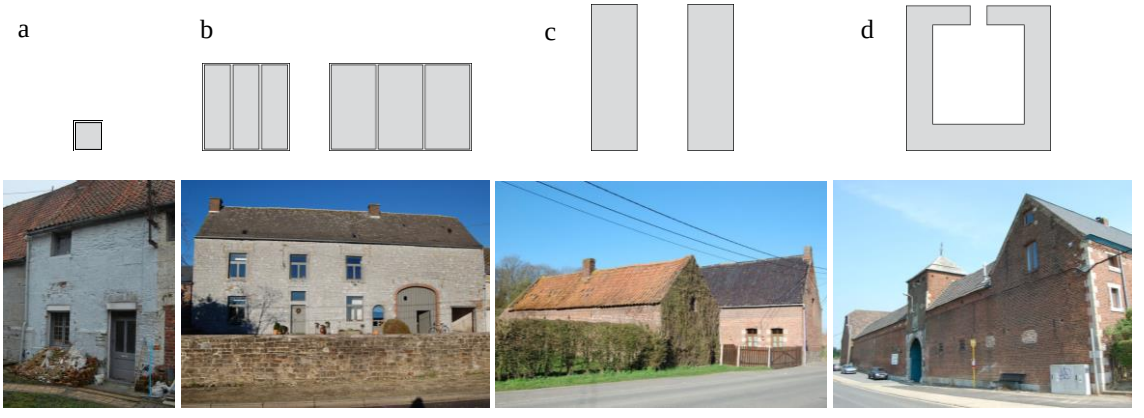

Fig. 4. (a) Worker’s dwelling; (b) “Farm in block” - “Lengthwise farm”; (c) “Farm with parallel buildings”; (d) “Fortified square farm”

3.3. Selection, deep analysis of case studies and development of realistic dynamic simulation models

For each type and subtype, two representative case studies will be chosen: a listed building and a not-listed building. The comparison between these two case studies will distinguish two levels of possible interventions and target objectives in terms of energy performance.

The case studies will be analyzed in two parts: architectural description and building behavior monitoring. The architectural description includes several analyses: (1) the geometry (2) systems and (3) composition of building envelope and internal walls. Building behavior analysis includes (1) deep diagnosis of the building (with highlighting of existing pathologies) and (2) analysis of thermal and hygrothermal behavior (walls and the whole building).

Based on the deep analysis of case studies, dynamic simulation models will be developed. These models will be calibrated on the results of monitoring and in situ measures. They will be used for retrofitting strategies validation of intervention (energy and hygrothermal criteria).

4. Retrofitting strategies (by dwelling type and subtype)

According to the specificities of each studied dwelling type, the methodological tool will identify and propose to adopt strategies of retrofitting (architectural, material or technical). In function of target objectives, the project contains a list of renovation or improvement measures. These recommendations will be prioritized: essential, necessary, ideal or possible.

Proposed retrofitting strategies will support improvement of indoor comfort and energy performance of buildings and also reduction of the global environmental impact while integrating preservation of heritage value and reducing risk of building pathologies. Retrofitting strategies will then be assessed on the basis of indoor comfort criteria as well as energy, environmental and heritage value criteria.

5. Conclusion

The paper presents the methodology used to analyze and characterize the Walloon existing dwellings stock. The data will be used to develop a tool to help improve global performance of this urban and rural area. The study of old dwellings allows the suggestion of adapted retrofitting strategies. Indeed the particularities of each dwelling type (“maison bourgeoise”, modest house, fortified square farm…) offer different possibilities of retrofitting. This methodology can be applied in other contexts to help any user with data on different scales, from the building to the entire city, to make sustainable decisions.

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