Flexibility in the First Generation of Reinforced Concrete Housing: a Public Housing Estate in Lisbon

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Introduction

The use of the built environment changes over time as people's needs change and as a result of broad societal trends. Particularly in the housing field, rapid changes have been occurring in family size, composition and structure and in expectations of comfort and efficiency leading to improvements in dwelling space.

Research on how households deal with the physical quality of their dwellings has generally agreed that the differences in housing improvements were not only associated with the social and economic characteristics of the households, their lifestyles, housing aspirations and values, but also with the spatial and constructional features of the houses. Housing improvements (i.e. the increase of housing quality through renovation, alteration or replacement of construction works) are mostly determined by size and dwelling type, as well as by the flexibility of the buildings. The concept of flexibility means the capacity of a built structure to allow for improvements through the conversion of the spatial layout (i.e. the spatial convertibility potential).

This paper aims at analysing flexibility in the first generation of reinforced concrete buildings (FGRC) constructed in Portugal and to identify their potential for spatial convertibility in order to avoid unsuitable interventions. It is based on an inner-city housing estate in Lisbon developed during the 1940s as an extension of the city centre. The estate comprises 302 buildings making up the FGRC: structures with masonry load-bearing walls, timber floors and reinforced concrete slabs in 'wet' areas (kitchen, toilets and bathrooms). Prefabricated components were also introduced as part of the innovations (e.g. doorsteps, window frames, concrete blocks). Success led the official authorities to apply this type of building in others parts of the city and to invest in further social housing programmes. Almost fifty years after the completion of this housing estate, it now appears as a consolidated neighbourhood. The urban, architectural and constructional characteristics make it distinct from the rest of the city and contribute to its present attractiveness.

Since 1991, tenants have been allowed to buy their houses, and to sell them after a period of five years from the date of purchase. This led to a 'gentrification' process known as incumbent upgrading, i.e., the spontaneous improvement of the dwellings following the upward shift of the socio-economic status and needs of the current inhabitants and the inflow of new owners with a higher income and education than the previous ones.[1]

A post-occupation evaluation was carried out to identify the nature and range of improvements made by households.[2] The survey lasted for a period of four months, starting in spring 1998. The method was based on the participatory process of building evaluation proposed by Preiser: a mix of building evaluation such as archival and document evaluation; walkthrough inspections; a generic evaluation checklist in the form of a door-to-door inquiry; and interviews.[3] Two types of inquiry were carried out. One was directed towards households and another to the condominium managers. Interviews with building contractors involved in the refurbishment works were also carried out.

Inquiries to households used visual mapping techniques to allow householders to identify in the house plan the sort of improvements they had made. This information was complemented with a standardised

questionnaire based on pre-coded responses concerning physical and social issues in the dwelling as well as its functional and building performance. These inquiries were posted to 537 households and 69 condominium managers. After a fortnight responses were gathered together, leading to a sample of 107 answers from households and 22 from condominium managers.

The survey has shown that households were likely to carry out some form of alteration (such as maintenance, repairs or improvements) within two to three years of purchase of the dwelling. The same applied to improvements at the building scale conducted by the condominium. The building works were often executed with lack of technical knowledge concerning the built structure and without formal submission or licensing for approval. Most of the households were misinformed about matters relating to building works and some of them were executed without complying with standards of safety and amenity prescribed in the building control regulations.

The paper is divided into three parts. The first sets the study in context by giving a general overview of public housing policy in Lisbon. It is focused on the social, political and urban background to the conception of the case study. The second part refers to the case study and describes the built fabric and the building process. The third part considers the improvements made by householders and assesses the space convertibility potential.

Public housing policy in Portugal

In Portugal direct state intervention in the production of affordable rented housing, referred to as social housing, started in 1933, although some legislative measures were introduced in 1918, during the first republican period. Between 1933 and 1945, social housing programmes were restricted to the construction of single-family houses according to garden city-inspired principles, reflecting an official moral attitude and feeling of rural nostalgia. Most of the schemes consisted of two-storey houses, mainly of semi-detached form with small private rear gardens arranged about road patterns forming closes, squares and other spaces characteristic of garden city layouts.

After 1945, the economic and demographic context and housing shortage affecting the main cities, in particular Lisbon and Oporto, imposed a change in social housing policy. Modern architecture models based on multi-family building types became more compatible with the goals and strategies of the capitalist model of development under way. Design moved away from the garden city idiom of low-rise, traditionally built houses to high-rise building schemes. Production of social housing increased and the buildings became more standardised and made by industrialised methods.

In the city of Lisbon, social housing programmes may be classified into two distinct groups, in terms of size and urban development strategies, ranging from small housing estates to large residential areas. The first group consists of isolated housing complexes, in general four-storey buildings without lifts, built by the local council in peripheral and segregated urban areas. The second group corresponds to large-scale urban developments as part of the process of urban expansion. They were carried out from 1944 to the 1970s by the city council in close association with central government. During this period, council decisions in terms of urban design were taken within a framework of government housing policy being responsible for building public facilities and the larger part of the housing stock. Multidisciplinary teams co-ordinated by an architect-planner working either as a consultant or as a chief officer prepared the master plans. During the whole process a continuous advance in urban design strategies and architectural design solutions occurred, reflecting the planning approaches and trends.[4]

The Alvalade experience

The area under analysis, known as Alvalade, corresponds to the first large-scale urban operation planned to expand Lisbon by public initiative during the second quarter of the twentieth century. The Master Design was prepared at the beginning of the 1940s. It was integrated in the structure plan of

Lisbon, proposed in the City Master Plan elaborated in the period 1938 - 1948 by the French urban planner Etienne de Gröer, and it promoted the northward expansion of the city centre in response to the housing shortage affecting the city.

Figure 1. City master plan (1938-1948).

The area, of about 230 acres, was planned to integrate a total of 12,000 dwellings promoted by the public and private sectors, activity centres including schools, market, civic centre, and small industries. A population of 45,000 inhabitants, with different income levels and social status was proposed. The first set of 84 social housing buildings was inaugurated in 1947.[5]

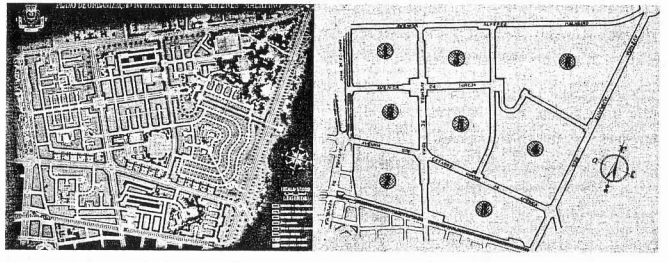

Figure 2. Alvalade Master Plan: urban layout.

The urban layout applied concepts and influences characteristic of the first decades of the twentieth century. A net of principal axes defining eight cells or 'neighbourhood units' divides a rectangular hierarchical grid. The hierarchy of the street system and public facilities, and the freeing of the inner part of the blocks for collective use, give shape to the urban design principles applied.[6]

The cells are structured from a central element, the primary school, around which housing blocks are distributed. Their average dimension was calculated so as not to exceed a distance of 500 meters from school to dwellings. Footpaths crossing the back yards of the blocks connect dwellings and school. Public facilities, in particular the market and the civic centre, are distributed in such a way as to be accessible by the dwellers of each cell through comfortable and short paths, which occasionally cross the main arteries. Within each cell, local streets provide direct access to buildings.

The plan implementation started with cells I and II. It provided for the construction of 302 buildings of affordable rented housing comprising a total of 2066 dwellings. The city council and the housing development agency, Federação das Caixas de Previdência (FCP), financially supported the operation. According to the contract signed between them, the council was responsible for the general urban plan, the architectural housing project, the technical, economic and social studies and planning of the works, including the definition of deadlines for execution and programmes for the different stages of construction. The supply of building materials and production of prefabricated components were also the responsibility of the city council. For its part, FCP paid expenses of the contractors, builders and suppliers, as well as the cost of supervision and control of the construction works.

The inclusion of small scale building types, up to four storeys high without lift and with innovative ways of housing promotion, made the venture financially viable. Housing supply was diversified in such a way as to include different market values thus allowing a balanced social fabric. The use of innovative processes in the building programme, based on model plans and layouts, as well as building construction and management, was responsible for the success of this operation. The shift from production to design represented an explicit move towards quality rather than quantity as the parameter for evaluation.

The buildings fit in a block typology with a rectangular plan. They were grouped in open blocks, allowing the existence of common back yards. They show a consistency in character, which stems from policies, building regulations and cost limitations formulated in the master plan. Formally, the buildings are characterised by orderliness and a small variation of the elements of architectural composition and building materials which give an external image of great unity. The plain architecture is a cultural declaration of simplicity.

The house-plan layouts are based on the rationalization of spatial and functional organization. Nine different house type-plans, grouped in three series of basic types each, corresponded to the economic levels and household size of the families. The rationalization of the spatial layout was based on the study of meaningful indexes by applying Alessandro Klein's analytical methods, also designated the "Method of the Signs". Klein developed a scientific approach, undertaking systematic mathematical analyses of housing plans, which he published in 1927. Klein used this functional approach in the design of residential developments in Berlin, including those at Wilmersdorf (1927) and Zehlendorf (1928-9). It consists of studies of the relationship between the different functional housing spaces according to different periods of the day, allowing the selection of the plan that demonstrates the best space-use conditions. These studies were applied in the design of the FGRC and resulted in an increase of the habitable area through the integration of the corridor into the living room and the reduction of unused spaces. Above all, the purpose was the rationalization of the house in such a way as to 'increase the value of the house by reducing the area to the compatible minimum'.[7] The use of innovative design approaches allowed good dwelling conditions such as through ventilation and natural light in all the rooms. Inner yards were suppressed and dark and humid corners avoided.

All the nine house type-plans show the same pattern of functional relations. The social zone (living room) occupies the central space of the dwelling, promoting the connection between the private zone (bedrooms, toilet and bathroom) and the service zone (kitchen, laundry and pantry). The private zone is located in the deepest area of the spatial layout. In each series the types are defined according to the number of bedroom spaces; the difference between series I and II refers to the introduction of an office-room and an additional space in the service zone. From series II to III, the difference consists of the introduction of an additional area close to the service zone with a small bedroom and a bathroom for a servant.

The rationalization and simplification processes applied to the study of housing layout were also applied at the level of construction, with solutions directed at concentrating the kitchen and sanitary plumbing, a rigorous choice of materials and construction processes, as well as careful planning and management of the construction works.

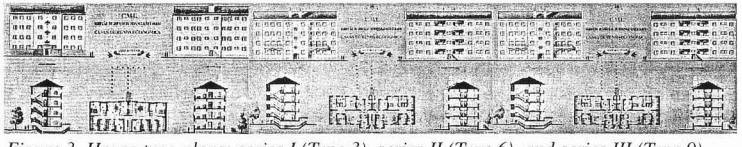

Figure 3. House type-plans: series I (Type 3), series II (Type 6), and series III (Type 9). Plans, cross section and elevation.

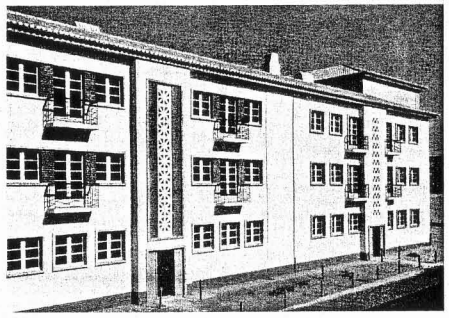

Figure 4. Affordable rented housing. Conclusion of the first group

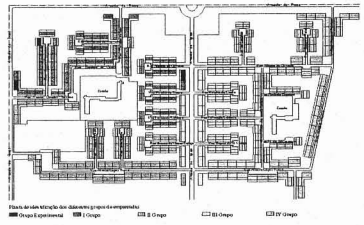

Figure 5. Identification of affordable rented housing belonging to each construction group. Plan.

Construction started with an experimental group of three buildings of different types (Types 3, 6 and 8). This option allowed the adopted solutions to be tested, both from the point of view of conception and of construction technologies, providing useful lessons for the implementation of the overall programme. The cost of construction of this experimental group, while being greater than forecast, became self-rewarding in as much as it allowed modifications to be introduced in the construction of the houses which followed.[8]

Figure 6. Cells II and I: Aerial view showing buildings under construction.

The construction of the remaining 299 buildings was divided into four contracts each with a similar workload. Together with the construction phases, the supply of materials and construction elements were organized according to the general plan of works in order to guarantee regularity. There were independent programmes for supply of timber, windows and doors, aiming at an improvement in the quality of these elements; an action programme was also planned for the supply of plumbing, concrete tiles, sanitation equipment, bricks and roof tiles.

The standardization and prefabrication of some construction elements allowed for reduced costs and faster construction: prefabricated elements such as doors, windows and cladding; standard concrete elements for steps and window lintels and sills of standard dimensions; and standardised components for water supply, drainage and electricity.

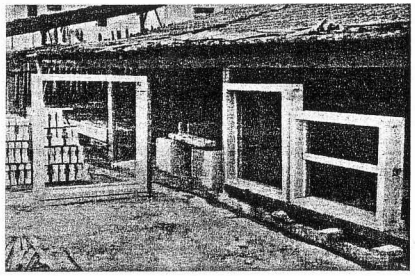

Figure 7. Standard concrete elements: exterior windows lintels and sills.

Throughout the construction process some innovative tests of materials and assembly processes were performed. In particular they were applied to concrete without fine aggregates, to studies of the most adequate cement mortar for interior and exterior and to the production of masonry, particularly concrete blocks. Studies related to plaster and timber were also developed by the Laboratory of Civil Engineering. For the timber an improved treatment was proposed allowing for better quality windows and doors. Through the different construction phases, the quality of ironwork was improved by creating more functional and economic types, while waste plumbing, sanitation equipment and hydraulic tiles satisfied predefined requirements of quality and fabrication. Employing concrete block masonry rather than stone and bricks led the municipality to acquire plant for manufacturing blocks, thus trying to satisfy technical and economic conditions and stabilise production.

These buildings belong to a period of construction which characterised the first half of the twentieth century in Portugal: the transition to reinforced concrete. As mentioned above, its execution was divided into four groups of contracted works. The first three were characterised by the use of stonemasonry (hydraulic masonry) in the external walls and brick in the partition walls, strengthened on all floors by reinforced concrete ring beams at the height of the window lintels. The floors of the wet areas, kitchens, toilets and bathrooms, were built with reinforced concrete slabs. The remaining floors were made with timber beams and Portuguese floorboards. The stairs were built with prefabricated concrete steps, supported by brick risers. The fourth group was characterised by the use of hollow concrete blocks in the outer walls, by solid concrete blocks in the front walls and by stone or plaster in the partition walls. The roofs were made of a timber structure covered with traditional ceramic tiles. The windows were in pine wood and the outer walls were plastered with cement and sand.[9]

The present situation

Fifty years after its completion, this residential estate has become a distinctive neighbourhood in the city of Lisbon, with unique urban, architectural and construction qualities. During this time, the buildings have been subjected to changes at different levels: physically in the dwelling and building, socially in the population, and functionally in the use of the buildings.

At the physical level, the buildings show ageing and deterioration of their constructional elements due to weather, pollution and lack of maintenance. The improvements that are being made by the homeowners to face these problems may increase deterioration in the state of the buildings.

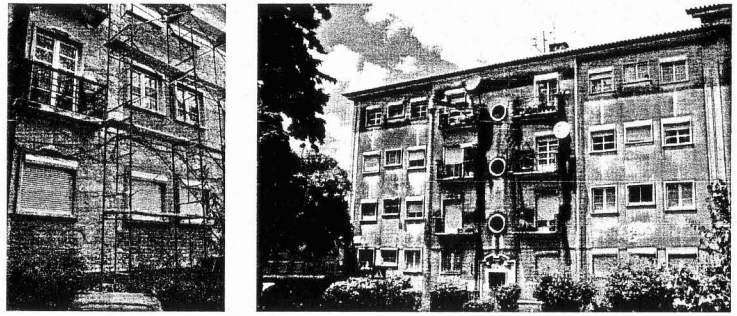

Figure 8. Exterior views of the buildings

These improvements are both at the scale of the building and that of the individual dwelling. At the building scale, the interventions are mostly related to the replacement of the timber roof and roof tiles with similar ones, the restoration of external facades, the replacement of water, gas and electricity distribution, the installation of cable TV network equipment and the fixing or replacement of existing stair, floor and wall finishes.

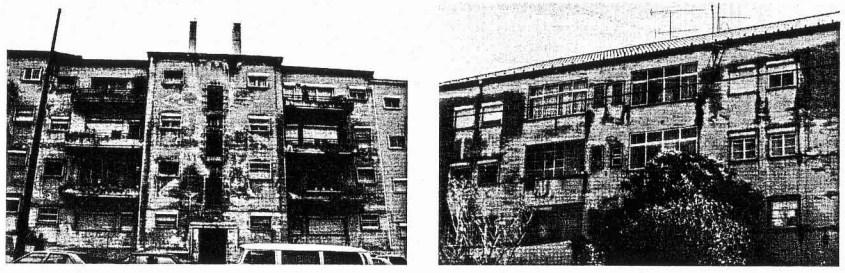

Figure 9. Exterior views of the buildings (Type 7)

At the dwelling scale, the improvements do not fit a regular pattern. They can be classified into two main groups, one concerning light building works and the other concerning alterations of layout. Light building works include: replacement of kitchen dressers, bathroom equipment and wall tiles; restoration or replacement of existing floor and wall finishes; introduction of false ceilings; enclosure of balconies with the use of window panels; installation of grilled doors or roller shutters; replacement or changing of window materials from wood to metal and the installation of supports for air conditioning units on the exterior.

The second group of improvements involves: demolition or erection of partition walls; creation or sealing up of wall openings; demolition of parts of external walls to integrate balconies into the liveable area; and creation of openings in the ceiling to gain access to the attic from the top floor dwellings. The most common alterations concern enclosure of the living room and expansion of the social zone. By enclosing the living room, homeowners intend to make a direct connection between the entrance and the private zone, thus avoiding passage through the living room. This alteration involves the erection of new partition walls and the creation of new circulation paths. The social zone is generally increased by converting one of the bedrooms into living space through the demolition of partition walls or creation of wall openings. Bathroom improvements can also involve demolition of existing partition walls and erection of new ones, allowing a larger area and additional storage spaces.

In terms of functional changes the conversion of the office space (existing in types 7, 8 and 9) into

bedrooms was also observed. This alteration did not involve construction works and occurred mainly in households of elderly people. The conversion of bedrooms into storage space was also common when the household size decreased. Some of the most common alterations to be found are illustrated in the next figure and they refer to types 8 and 9.

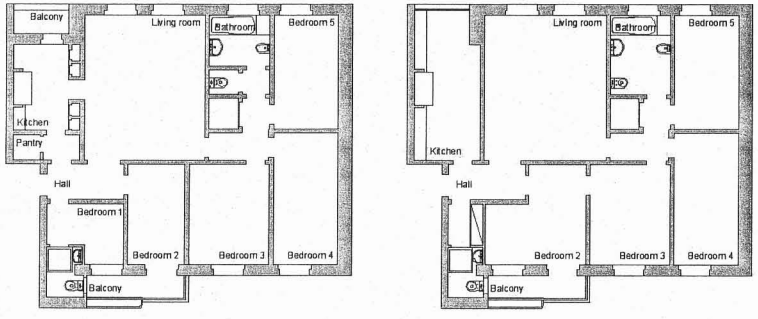

Figure 10. Type 8 - Original plan and plan with spatial alterations.

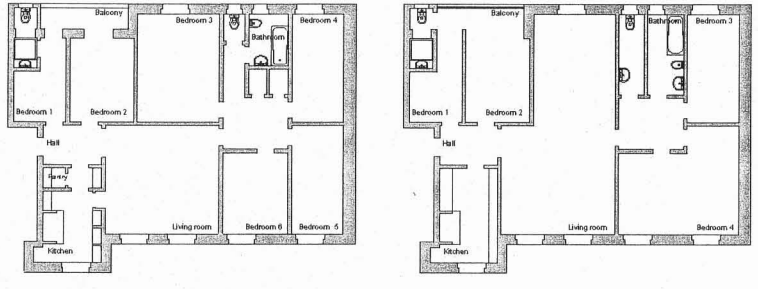

Figure 11. Type 9 - Original plan and plan with spatial alterations

Conclusion

Nowadays building flexibility is considered an important design factor in response to new demands placed on housing. Besides proposing freedom to choose among options that fit individual needs and aspirations, building flexibility also allows the possibility of adapting or upgrading according to future circumstances.

However, this study has revealed that the capacity of the FGRC to allow for changes through the conversion of the spatial layout is limited by the construction system. It was observed that some changes have had an impact in spatial and constructional organization. This resulted in interventions which, because of their depth and a lack of knowledge of the built reality, are responsible for negative consequences in the construction and structure of the buildings. Some of them do not comply with standards of safety and amenity prescribed in the building regulations. This applies, in particular, to the demolition of load bearing partition walls that support the timber floor beams. This results in deflections of the floors and, for instance, vibrations caused by people walking on upper floors. The construction of

new partition walls overloads the floor beams upon which they rest, resulting in further deformation. Moreover, the demolition of load bearing partition walls perpendicular to the façades reduces the seismic safety of the building. The demolition of part of the external walls and the closing of balconies also diminishes the structural resistance of the building, especially if carried out on lower floors.

These interventions are carried out by the homeowners without any technical support or the setting of quality levels to guarantee adequate levels of security, habitability and economy. They are rapid and non-expensive solutions that in the short term may prove ineffective and possibly even increase the deterioration of the buildings. There is no technical support or regulations set by the municipality of Lisbon to control these individual rehabilitation actions.

Alvalade constitutes the first experiment of comprehensive urban planning, defining norms and rules at an urban, architectonic and constructional level. The elaboration of building regulation that establishes specific rules of action, guaranteeing the goals of an urban rehabilitation programme, is regarded as imperative. An experienced multi-disciplinary team in rehabilitation should support this process, in order to protect the aesthetic and urban unity of the housing estate.

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