Building pathologies in social housing: the portuguese state of art

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Abstract

During the XX century, a great intensity of new buildings construction was occurred, representing these buildings an enormous patrimonial valour, which require a permanent investment in management, maintenance, repair and rehabilitation. To provide adequate qualitative and quantitative levels of housing, great economic investments have been made in social housing, what implies the necessity of realise a study on the physical conditions of the built public housing park, with the aim of knowing about the necessity and viability of rehabilitation interventions in order to achieve quality and durability. Rehabilitation investment in the built environmental, beyond contributing for the preservation of the existing patrimony, contributes for the implementation of construction sustainable politics, through the reduction of the consumption of natural resources and energy, of the reduction of residues proceeding from the construction activity and for one better management of ground occupation. In opposition to this, has been registered a quality and durability decrease of the public and private built environmental through its precocious degradation. The aim of this paper is to identify the principal anomalies which appear in portuguese social housing buildings, based on a bibliographical research. This work aim to find design and construction solutions with a minor durability, to be eliminated in future projects.

Keywords: social housing, anomalies, deterioration state, durability, rehabilitation.

1. Introduction

Throughout the times, housing is a constant necessity of the populations, as in quantitative terms as in quality terms. The governments of the industrialized countries to make face to the lodging necessities had established several housing politics, not leaving in this way, the only alternative to the private offers, in the respect to the financing, construction and attribution of lodgements [1].

The lack of lodgements, associated at the low economic resources of determined population stratus, had taken the Portuguese State to invest in social housing

construction, with bigger intensity since 1974. However the deficient quality control in the construction of these houses, the absence of studies on the global cost of the buildings and of the respective degradation models, as well the absence of maintenance planning, was expressed in the lack of durability and in the precocious and accentuated degradation of these buildings. Associated to these factors, the aging of this housing park and the lack of the economic resources necessary for its maintenance and rehabilitation had aggravated its physical degradation that is still more serious than in the private sector. The urban, economic and social problems associated to the social housing areas, had taken to the development of many studies and management models of these zones aiming on urban, economic and sociological aspects [2]. However the resolution of social problems that exist in these areas, as well its urban regeneration implies the necessity of the build environment preservation through its priories and planned maintenance and rehabilitation. To initiate this process the identification of the most pressing problems must be done. An important aspect to have in consideration, ever in new construction ever in any intervention on the built environment, is to give the privilege to durability and easiness of maintenance in opposition to the low initial cost of the construction. By other side the rehabilitation of the built environment is essential to get housings with good conditions, so it must be promoted techniques that conjugate the cost-effectiveness and the durability of the interventions. To reach this relation must be established clear commitments since the planning, design and construction phase, through the chosen of materials, systems and processes that allow the performance waited for the users, as well easiness of repairing or substitution, when necessary [3]. On the other hand the characterization of the main anomalies that occur in the buildings, allows the identification of the less efficient solutions and the consequent elimination in future projects.

2. Rehabilitation and sustainability

In Portugal the recognized lack of durability and quality of the social housing, associated to absence of support programs to its rehabilitation takes that a high number of these buildings presents different levels of degradation, with the consequent urban and social degradation [4]. To mark one of the goals established for the document ENDS 2005-2015 [5]:*"Adopt and implement, until 2010, a national Strategy to the Towns that take to place the Local Agenda 21 principles, that integrate the urban rehabilitation dimension at least in 80 % of he local municipality",* what passes for the development of politics that lead to the implementation of the line of orientation pointed there*:* "to *stimulate the urban rehabilitation, favouring the diffusion of the urban lease and the integrated operations of recovery of degraded urban areas",* the priority to achieve this goal is the characterization of these buildings degradation degree, to decide on the necessity of the respective rehabilitation to be taken.

However the importance of the social housing park, in the quantitative housing necessities satisfaction of the most disfavoured population stratus, it is essential that beyond this satisfaction it presents levels of quality that allow good habitability conditions at the lodging and urban level. These parks managing entities need instruments that allow them to identify the intervention necessities in a priories form and which results support their decision about the intervention to effect. For these instruments elaboration it is necessary to characterize the type of anomalies that affect these buildings, so a bibliographical research has been done and presented hereby.

3. Buildings anomalies

3.1 Deterioration of buildings

The cities, the buildings and all infrastructures have a life cycle with some analogies with human life cycle. The analogy we can do is between the building deterioration and the human aging process. Both processes are inevitable and progressive but buildings and humans need during their lives to be object of maintenance, repair and rehabilitation aiming the prevention of degradation. The deterioration process observed in buildings is a natural process that occurs through the time, which results are not only the result of human error, during the design, the construction and utilisation phase. By this author, the deterioration mechanisms are the consequence of the reaction and interaction of two independent variables: the physical object and the environment. The building deterioration begins immediately near their completion. These deterioration mechanisms achieve firstly the materials in a sub optical level. This is referred as the “incipient period” – the deterioration has begun in despite the apparent absence of damage. This period is followed by a period of “accelerated deterioration”, in which the mechanisms initiated in the incipient period begun to coalesce and converge and became visible. In a short period of time the components begin to fail, and its progression ends with the total system fail and the building is abandonee or condemned to demolition. The last stage of building deterioration is the “deceleration period” that may or not begin with the abandonment that implies the absence of intervention and the continuous deterioration until nothing more rest of the building. In spite of the building elements deterioration are a normal consequence of the aging process, some factors exist that influence this process, as the construction quality, climatic conditions and the lack of maintenance actions. The negative influence of the absence of measures to control the deterioration process, takes the increase of costs and the deep of the intervention needed. These measures consist in maintenance, repair and rehabilitation taken in all the elements of the building. [6]

The life cycle duration of the building elements depends not only from the chemical, physical and mechanical properties, they have from its manufacture, but also from the lack of maintenance and from the climatic conditions [7]. So to determine the building degradation rate it must be considered two groups of factors that contribute to develop the deterioration mechanisms, like referred in table 1.

Table 1 – Building deterioration factors

1 – Building conditions (durability)		**2 – Environmental conditions (deterioration factors)**	
During design and construction phase	Project Specifications Planning Materials Construction	Natural conditions	Temperature Humidity Solar radiation Wind Rain Salts
During the using phase	Maintenance Repair Substitution	Artificial conditions	Factors from atmospheric pollution Factors from using conditions Factors that appeared in consequence of the project options

Source: Adapted from AIJ, 1993 [8].

By other side through its service life a building must comply with a series of criteria which can be grouped in [9]: functional specifications, performance specifications, legal specifications, user specifications. For each criteria, subjacent principals of maintenance, repair and rehabilitation operations, must have the aim of fulfil to the legal requirements, to provide easy future interventions (including the necessary registers to be done in safety), to satisfie the functional, the performance and the user specifications, as well eliminate all the anomalies and decrease the deterioration rate, so contribute to optimize its service life. The ISO 6241:1984 contain by categories the different user requirements that buildings must satisfy through its service life, that must be applied to the indoor spaces or to the envelope, independent of its localization or its conception, and to the entire building or only to some of its parts. The ISO 15686-1:2000 presents these specifications in its Annex D [10], [11].

3.2 The main anomalies detected in buildings

The statistical analysis given by the 2001 Censuses allows knowledge in quantitative and qualitative terms about the buildings degradation/conservation state that existed at that date, not allowing however, to have the knowledge about the conservation state of the social housing that exist through the country. By that statistical data, specifically by

that one presented in table 2, it is verified that in Portugal, relatively to the total of constructed buildings, exist 40% of buildings with structural anomalies, 45% with roof anomalies, 47% with anomalies in the external walls and frameworks. So we can conclude that the buildings envelope present a high rate of anomalies, which frequently implicate internal deterioration in housings.

Table 2 - Buildings, by construction period, by repair need

Geographic zone		Construction period								
Repair needs	**Total**	**Before 1919**	**1919-1945**	**1946-1960**	**1961-1970**	**1971-1980**	**1981-1985**	**1986-1990**	**1991-1995**	**1996-2001**
T: Portugal										
In structure	3160043	253880	344936	357042	395262	553349	359579	289351	279146	327498
None	1889502	55493	100305	141195	203481	362178	263452	230285	236386	296727
Small	610220	49401	84365	96721	105689	120477	65079	40906	29067	18515
Median	372304	56730	79509	71302	58439	50845	22682	13126	10707	8964
Great	184860	49500	52295	33578	20210	14734	6219	3735	2215	2374
Very Great	103157	42756	28462	14246	7443	5115	2147	1299	771	918
In the roof	3160043	253880	344936	357042	395262	553349	359579	289351	279146	327498
None	1737389	42981	83052	117820	177322	325697	245670	220147	230362	294338
Small	627559	43603	78907	95451	108953	132537	72355	45353	31554	18846
Median	430521	61037	86646	82251	70503	64895	29176	16433	11322	8258
Great	236135	56867	62140	43191	28362	22496	9305	5503	4173	4098
Very Great	128439	49392	34191	18329	10122	7724	3073	1915	1735	1958
In the external walls and frameworks	3160043	253880	344936	357042	395262	553349	359579	289351	279146	327498
None	1671342	44550	83311	115174	170805	312272	232515	208554	219690	284471
Small	698968	46998	82758	101338	117974	146932	83234	54364	39837	25533
Median	444984	60648	86351	82620	71355	67700	32251	19358	13681	11020
Great	222494	54285	59456	40768	25736	19725	8619	5193	4258	4454
Very Great	122255	47399	33060	17142	9392	6720	2960	1882	1680	2020

Source: Censos 2001. INE, Recenseamento Geral da População e Habitação – Resultados Definitivos [12].

It is relevant the great incidence of these anomalies in the buildings constructed after 1971.

3.3 Anomalies in social housing buildings

About the main anomalies identification and characterization that appear in social housing buildings the data presented hereby were obtained from several studies. The diversity of social housing programs realized along the years, have had as result a great diversity in dimensions, typologies, housing standards and degradation state, as it is referred in table 3.

Table 3 – General aspects of social housing degradation

Typology/Construction period	Characteristics/Degradation state
Individual houses from the decades of 30/40 to 90	Reduced dimension, application of well knows and tried construction processes, take to punctual physical degradation, frequently solved by the residents.
Buildings of dwellings from the decades of 40 to 60	Reduced dimension, application of well knows and tried construction processes, take to punctual physical degradation, especially in the external frameworks and finishes.
Small buildings of dwellings from the decades of 70 to 90	In spite of its reduced dimension, it can be finding in these buildings, degradation situations resulting from the use of unknown and less tried construction processes, resulting from the unloading external walls.
Great dwellings buildings from the decades of 70 to 90	These buildings have the great concentration of the greatest problems. They present high degradation levels resulting from constructive problems, dues to deficient's construction solutions, dues to the implementation of unknown and less tried construction processes and materials, and the conjunction of problems between construction, equipments, components, facilities, functional solutions to buildings and lodgements.

Source: Adapted from Cabrita et al. (2000) [13].

It is also relevant, in this table, the great incidence of anomalies in the buildings constructed after 1971, which occur in similarity with the generality of the constructed buildings, justified in part with the increase of the number of constructed buildings after this decade.

In the analysis of the behaviour of the applied rehabilitation solutions to 32 social housings sets, constructed in the north of Portugal, with a total of 4200 lodgements, has been done a study about its envelope behaviour, special in the external walls. These set of buildings was subject to rehabilitation operations in its envelope – roof, external walls, frameworks, joint zones, drainage facilities. Before these works have been identified as more frequent anomalies [14]: walls coatings crakes and penetration of rain water inside the lodgements; the aging and detachment of waterproofing material in the joint between the framework and the wall; the lack of mechanical resistance of the brick cover in the warping; the degradation of the rain water drainage facilities; the lack of elasticity and consequent crack and detachment of the waterproofing material in the expansion join between buildings; dampness in the interior of the ceilings of the higher lodgement, because the lack of waterproofing layer in the roof. After the rehabilitation operation have been observed that the more frequent anomalies detected are: at the roof level - the deterioration of waterproofing metal elements in the top and in the joint of

vertical elements with the roof and consequent appearance of dampness in the external walls; at the external walls - coating cracks, detachment of the coating, dampness, deterioration in the concrete surfaces; in the glass surfaces - deterioration of parapets, someone with punctual breaks, deterioration of the waterproofing material in the joint between the framework and the wall, and consequent degradation of the framework; the rain water drainage facilities presented deterioration of the paint coating, detached and break pipes. It could be observed in more than 50% of the deterioration cases, the detachment and cracks of the waterproofing material in the expansion joints of the buildings.

After the rehabilitation operations have been taken, it can be verified the incidence of similar anomalies. These anomalies implied negatives effects in the performance of the elements of the buildings envelope, especially in respect to waterproofing, thermal-hygrometric and durability requirements. About the durability of the rehabilitation solutions used, they weren't the more efficient because in the evaluation after that works, 31% of the set of buildings were classified as deteriorated or much deteriorated, between 6 to 9 years after that works have been taken. Equal percentage was classified without apparent deterioration in a period of time less or equal to 4 years, from the rehabilitation works. One case, at the end of 9 years, after that works, had little punctual deterioration and two cases that at the end of 4 and 5 years respectively, had low deterioration with some punctual situations. The others cases presented deterioration or great deterioration especially after 6 years, after the rehabilitation that have occurred (Table 4).

Table 4 - Deterioration evaluation synthesis after the rehabilitation

Global evaluation after the rehabilitation works	**Number of buildings sets**	**Percentage**	**Δ t ***									
			0	1	2	3	4	5	6	7	8	9
D1 – No apparent deterioration	10	31,3 %	1	2	5	1	1					
D1-2 - No apparent deterioration to slightly deteriorated	2	6,3 %				1						1
D2 - Slightly deteriorated	5	15,6 %								3	2	
D2-3 - Slightly deteriorated to deteriorated	5	15,6 %					1	1		1	2	
D3 - Deteriorated	4	12,5 %								1	3	
D3-4 - Deteriorated to accented deterioration	2	6,3 %									2	
D4 - Accented deterioration	4	12,5 %							1	2		1

Δ t * - time interval between the rehabilitation interventions and the technique evaluation after rehabilitation. Source: Adapted from Abrantes et al., 1999 [14].

It would be essential that must not persist too much short cycles of rehabilitation/degradation, through the guarantee of the durability of the found

solutions, contributing itself for the increase of the economy of the interventions and for the environment preservation. On the other hand it is necessary that the rehabilitation interventions decision, to be taken in these buildings, must be based on studies that guarantee the satisfaction of specific levels of performance, the solutions durability, the consequent increase of the service life, the reduction of maintenance and repairing interventions, the introduction of systems, components and materials that contribute to facilitate any future intervention.

About the planned service life determined during the design phase for parts of buildings, elements and components, in accordance with AIJ, 1993 [8], table 5, the roof coatings must have a service life more than 30 years (Yo 40), the drainage facilities a service life more than 12 years (Yo 15), established by similarity with the water proofing layer, and the external wall coatings a service life more than 8 years (Yo 10), and the ceramic wall coatings more than 20 years (Yo 25).

Table 5 – Recommended class of planned service life for parts of buildings, elements and components

Object		**Class of planned service life**
Load bearing elements (including foundations)		Equal to or more than Yo t
Non load external wall		Equal to or more than Yo t if the replacement is difficult Other than above, more than Yo 40 or equal to or more than Yo t
Partition wall		Equal to or more than Yo t if the replacement is difficult Other than above, more than Yo 15
Roof	Roof covering material	More than Yo 40 or equal to or more than Yo t
	Water proofing layer	Yo 15 or more
External finishing	Coating wall	Yo 10 or more
	Ceramic tiling	Yo 25 or more
Fitting	External	Yo 40 or equal to or more than Yo t
	Internal	More than Yo 40 or equal to or more than Yo t
Wiring		More than Yo 40 or equal to or more than Yo t, if the replacement is difficult Other than above, more than Yo 25 in other cases
Piping		More than Yo 40 or equal to or more than Yo t, if the replacement is difficult Other than above, more than Yo 25 in other cases

Source: AIJ, 1993. Table 2.2.3 pp. 9 [8].
Note: Yo t – the class of planned service life of the whole building.

Through the data analysis obtained in the referred previous study, and having as reference the time intervals in the table 5, and comparing the time interval that has elapsed between the building construction and the rehabilitation of these envelope elements, it can be concluded that: the pitched roof coatings are in 75% of the buildings set, in wavy asbestos-cement plate, and in 22% in ceramic tile. The expected durability

to roof coating is at least 30 years. In the referred study all the roofs had the coating deteriorated, and the rehabilitation operations have occurred between 14 and 18 years after the construction of the buildings with ceramic tiles and, between 9 and 20 years, with more frequency in the interval minor than 15 years, in the buildings with wavy asbestos-cement plate; the rain water drainage facilities were object of rehabilitation in 28% of the buildings set, before achieve the expected time interval to their planned service live; all the buildings were object of rehabilitation of their external walls, and it was verified that 62,5% of that operations has been taken 12 years after the construction, the superior limit of the durability interval for external walls coverings. The rest of the rehabilitation cases occurred in these interval; the concrete external walls, were in generality object of cleanness and painting, having verified a precocious deterioration in about 70% of the cases. It can be concluded that it is verified a great incidence of precocious anomalies in the constructive elements, due to a non suitable design solution, relatively to the choice of materials to be applied, conjugated with the low quality of construction works and with the absence of conservation and maintenance of the constructive elements.

The National Laboratory of Civil Engineering has been done the retrospective analysis of the social housing park financed by the National Institute of Housing, having in the 3rd Analysis [15], relative to the years of 1995 to 1998, done an inquiry to the residential satisfaction in which, a ordinal scale composed with 4 points was used, that allows the classification of the contemplated items, from the following values and meanings associates: 1 = No satisfy; 2 = Satisfies insufficiently; 3 = Satisfies; 4 = Satisfies sufficiently. The average of the scale is the value 2,5, for what in this study the appreciations situated below of this value represent negative levels of satisfaction, while that ones that are above of this value indicate positive levels of satisfaction. In respect to the lodgement the inquired had shown no satisfaction, nominated about the exterior sound isolation, the isolation of windows frameworks and doors, and to the temperature and ventilation of the house, as referred in table 6.

Table 6 - Residential satisfaction

Evaluated Category	Evaluated Items (referred)	Attributed Valuation
Lodgement	Satisfaction with exterior sound isolation	1,99
	Satisfaction with windows and doors frameworks isolation	1,90
	Satisfaction with thermal conditions of the house	2,34
	Satisfaction with house ventilation	2,27

Source: 3ª Análise Retrospectiva do Parque Habitacional Financiado pelo INH anos de 1995 a 1998, (LNEC, 2004) [15].

Relatively to the evaluation of the building the inquired had shown no satisfaction, among others items evaluated, relatively to the exterior aspect of the building, to the building construction materials and to the conservation state of the building.

Table 7- Building satisfaction

Evaluated Category	Evaluated Items (referred)	Attributed Valuation
Building	Satisfaction with the exterior aspect of the building	2,30
	Satisfaction with the building construction materials	1,97
	Satisfaction with the conservation state of the building	2,40

Source: 3ª Análise Retrospectiva do Parque Habitacional Financiado pelo INH anos de 1995 a 1998, (LNEC, 2004) [15].

According to these study these levels of satisfaction can be corroborated by the identification of anomalies registered in the housing, related with the construction and used materials, having been identified anomalies in 92,6% of the inquired lodgements, being 8, the average number of anomalies for each one. For the analysis of the results obtained it can be verified that 29.8% of the verified anomalies correspond to moisture manifestation in several compartments (sanitary installations, kitchens, rooms, interior and exterior walls and ceilings), 16.3% to wide and fine cracks (in interior and exterior walls and ceilings), 8.7% to problems in water distribution nets, 6.8% to problems in the nets of sewers and 38.4% to diverse damages ([15], adapted from Table 8: 243).

Of the entire analyzed studies, stand out the incidence of anomalies in the buildings envelope, which degradation degree must be identified and characterized. These anomalies often imply the appearance of several problems in the interior of the lodgements, with the consequent decrease of the habitability quality and of the inhabitant's satisfaction.

4. Conclusions

The results of the referred studies strengthen the importance of proceeding to the characterization of the degradation degree of the constructed social housing park, in order to justify the options for design solutions and for rehabilitation, in which it must be privileged more durable materials, systems and installations, with minimized and facilitated maintenance and guaranteed safety at work. So it is essential the guarantee of quality rehabilitation proceedings in which durability will provide a new image to the existing buildings, so important for the valuation and preservation of the constructed housing patrimony. To determine this degradation degree it is necessary to establish an objective method, from which it is, attributed a graduation to the buildings and/or its

elements and components that allow taking priories decisions on the type and depth of the interventions to take place in the building.The durability and consequently the life cycle cost of the building is strength related with the degradation mechanisms, being essential the determination of the degradation degree to decide itself about the actions to implement.Thus, to fulfil with requirements specification of the users, and with the components functions the building have to comply, having in account the factors that influence this performance, it can be identified possible degradation mechanisms and the respective effect, and establish degradation indicators, which work is in development.

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