Strategies for building pathology reports in a urban rehabilitation process. Project of the Old City Centre of Coimbra

R.S. Vicente, J.A.R Mendes da Silva, H. Varum
University of Aveiro, University of Coimbra
Department of Civil Engineering, University Campus of Santiago, 3810-193 Aveiro, Portugal
romvic@civil.ua.pt, raimundo@dec.uc.pt, hvarum@civil.ua.pt

ABSTRACT

The increasing interest on architectural heritage associated to the recognised building value, at economic, social and cultural levels have stimulated, in the recent decades, the urban rehabilitation and renovation o several cities in Europe.
Despite the strategy or method adopted in a city renovation process, its efficiency depends mainly on: type of buildings (structural systems, construction techniques and materials); intervention level (singular buildings, groups of buildings, urban zones, etc.); and, project objective (risk assessment, decision making to support future rehabilitation projects, definition of council maintenance policies, etc.).
In what concerns large renovation programs of old city centres, choosing the most adequate approach for inspection, appraisal and diagnosis is a complex task that can determine the success or failure of the project purpose.
This paper describes the preparation phase of the inspection of 700 buildings located in the old city centre of Coimbra (Portugal), where a global renovation process is planned for the forthcoming years.
In the scope of the renovation and rehabilitation process, the city council contract a complete identification and inspection survey of the buildings, directed on three different domains: (a) architectural typologies, (b) constructive and pathological condition of buildings, and (c) socio-demographic characterisation, of this part of the city. It will be present the check-lists developed and some of the obtained results on point (b), related to roofing systems, and exterior façades.
This diagnosis procedure shows that the inspection results quality is quite dependent on the items surveyed for each construction element (roof, façade, internal members, installation efficiency), as well as on the possibility of their correlation for a single building. The adopted method has been applied on 70% of the buildings inspected within the project perimeter.
Further treatment of the inspection and appraisal data will allow the developing pathology reports and list repair actions, and estimating rehabilitation costs. It will also help to produce defect level diagrams and seismic building risk maps, but, most important, to improve and guide a renewal strategy and intervention methodology for old buildings.

KEYWORDS

Building pathology, rehabilitation and renewal process, sustainability, inspection, appraisal and diagnosis.

1 RENOVATION PROCESS OF THE OLD CITY CENTRE OF COIMBRA

The old city centre urban and street structure of Coimbra has managed to prevail over the years. It is interesting to refer that, most of the ancestral physical and occupational characteristics of the old city centre have not changed through time: streets and alley lay out, traditional commercial activity; little groceries, shops and taverns, etc. The main reason for this fact is that Portuguese cities were not fustigated by the 2nd World War destruction and consequent reconstruction. The old city centre of Coimbra is delimitated on the left by the Mondego river and on the opposite side by the upper old centre and the University on the top of the hill, as shown in Fig. 1.

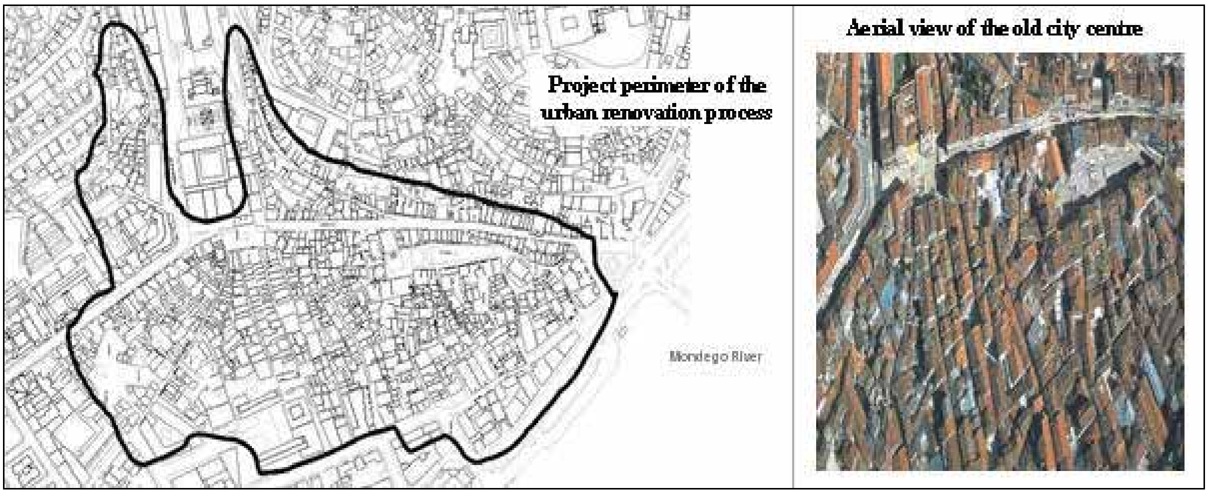

Figure 1. Plan and aerial view of the old city centre of downtown Coimbra.

Since the early 70´s, urban renovation programs of old city centres have become a significant scope of political and research activities, as a consequence of the increasing concern on urban sustainability and its public importance given by international treaties and conferences on this matter.

1.1 Old city centre of Coimbra

The renovation process that started a year ago in Coimbra is not the first national experience on urban renovation and rehabilitation. Other Portuguese cities have started renewal actions in the mid 70´s, little after other great European cities: Bologna [Donald Appleyard 1979], Paris, Barcelona, etc. These examples influenced our main national examples: Historical centre of Guimarães, Historical centre of Évora, Ribeira Barredo (Porto) [Oporto City Council 1998], Bairro Alto (Lisbon) [Cabrita Reis *et al*. 1992].

In order to survey and study the dowtown area of Coimbra, the project perimeter (see Fig. 1) was divided into eight zones (big city blocks). Each zone includes several buildings that share in many cases the same type of architectural, functional and occupational characteristics to be inspected and analysed with the purpose of in a final stage each zone is renewed as a whole.

The old city centre is divided in two main areas of population: “São Bartolomeu” and “Santa Cruz”. They are constituted by 721 buildings, in which 481 flats are unoccupied; resident population is of 1979 individuals (445 families); around 40% of the resident population is aged over 65 years; around 65% is unemployed in which 30% are pensioners or retired. The active population (around 57%) works in the area of residence and has very low wages, under 350€ (data obtained from the 2001 national inquiry). This area has a very important housing function. Concerning the degradation level of buildings, city council statistics (of 1998) indicate that around 48.1% does not present minimal living conditions and only 13.2% are in good condition of preservation. In respect to basic healthy conditions, referring specifically to the existence of toilets and shower-baths, 37.8% of flats, lack one of the mentioned basic needs [Coimbra City Council Housing Department 2003].

1.2 Type of buildings and construction elements

The dimension and nobleness of old buildings limits and defines the architectural typology and traditional construction techniques used. In respect to buildings with housing function, very simple structural schemes are observed: external load-bearing stone masonry walls, wooden floor slabs, and wooden roof trusses as shown in Fig. 2.

In the majority of buildings that have been inspected, we registered the systematic use of wood, in structural elements of floor slabs, roofing structures and floor coverings. Mainly the external load-bearing walls are abundantly of limestone masonry and the use of other materials, such as solid or perforated bricks is less applied. The use of river sand in mortars for bed joints and external renderings is also very common. In most cases roofs are covered with clay tiling of various formats. Window sashes are predominantly in wood and simple glazing windows are frequently seen. Interior partition walls are thin and sometimes suffer warping, revealing structural movements, often as consequence of creep and aging phenomena. Interior water systems are mainly made of cast and galvanized iron pipes and, in some rare cases, they are still made of lead; sewerage systems are made of grit stone and, more recently, they are made of plastic. Staircases have, typically, high slopes and use materials with high fire vulnerability, which makes difficult fire emergency evacuation. The majority of buildings are normally in bands with strait and windy accesses, constituting another negative fire safety factor.

Various types of load-bearing masonry walls	Clay roof tiling (fractures)	Wooden floor slabs (excessive beam spacing)	Interior partition walls (lath work with mortar)	Sewerage systems (bad drainage)

Figure 2. Construction details of old housing in the city centre.

Typically, these building have no underground floor, since the major area of this part of the historical centre of the town is quite close to the river on flat surface land (in opposition to the upper historical centre - not included in this study - that covers the mountain-side, enveloping the old University, erected on the top of the hill).

1.3 Motives of the urban renewal and renovation process

The visible degradation of buildings and their living, security and healthy conditions have come to such a degree where taking action must be somewhat urgent but prudent. The need to act in a organized and systemized way to improve the housing conditions of the old city centre in a political, social and coherent manner is our main goal for the next years.

The major purposes can be put into questions as: How to maintain the diversity of functions and occupations of the old city centre? How to adapt the old city centre to new and modern living conditions? How to stop the aging tendency of resident population? How to stimulate participation and interest of all groups involved in the renewal process? How to improve economic, social-cultural and commercial development? How to arrange such a process through time?
The renovation process must take into account, simultaneously, two different levels of interest: the physical renovation (structural and non-structural) and modernization of housing conditions, commercial spaces, public equipment and urban space; the social, cultural, economical and

environmental sustainability, in terms of energy efficiency, gentrification of population and functional services.

2 METHODOLOGICAL APPROACH AND PROCEDURE

Despite the strategy or method adopted in a city renovation process, its efficiency depends mainly on: type of buildings (structural schemes, construction techniques and materials); intervention level (singular buildings, groups of buildings, urban zones, etc.); and on the exact final project purposes (risk assessment, decision making to support future rehabilitation projects, definition of council maintenance policies, etc.) [Aguiar, J. et al. 1998].

Recently, new legal guidelines have been approved to create the so expectant and awaited SRU´s – Urban Rehabilitation Societies for some Portuguese cities (Coimbra, Oporto and Lisbon). These new societies will be implemented as a type of "neighbourhood councils" or "enterprise-city blocks" and they will be responsible, within the rehabilitation process, for defining and planning strategies, promoting and executing renovation actions. These societies are composed by city council housing department, owners, design engineers and architects, public and private investors and representatives of tenants. This political and administrative tool will sure help out on this complex and long process of urban renovation and renewal.

2.1 Methodology, strategies and difficulties

In the scope of the renovation and rehabilitation process, the city council invited the University of Coimbra to carry out a complete identification and inspection survey of the buildings on three different domains: (a) architectural typologies, (b) constructive and pathological condition of buildings, and (c) socio-demographic characterisation, of this part of the city.

Four teams of inspectors where created, three of them for each aspect mentioned above, and a fourth team to create a computer data-base to manage, inter-cross and analyse information gathered, using Geographic Information Systems platforms. The interaction between teams with different interests but with some common final aims is a decisive factor to contribute to a final and balanced solution. We will only discuss the second aspect mentioned above, related to deterioration and defects of buildings under the engineering point of view. This first stage – a complete inspection and identification survey – is the solid basis of the process and it is essential to acknowledge all variables and sensibilities involved, so that further stages, like the definition and proposal of various base-projects, correspond to building features inspected and identified. All this information individualized and recorded for each building in the computer data-base is a tool to promote and justify decision making and help develop in the future rehabilitation projects individually or globally in a larger scale – city block project.

The main difficulties that have been encountered in such a process are essentially: time deadlines, limited technical and economic resources, social, cultural and environment reality found in the field, re-housing of tenants and installation of construction work yards, priority decision making in critical cases, lack of knowledge of local and traditional handicraft, construction procedures and materials.

3 INSPECTION, APPRAISAL AND DIAGNOSIS

Choosing the most adequate approach for inspection, appraisal and diagnosis is a complex task that can determine the success or failure of the project purposes. This problem is particularly important when it is intended to inspect more than 700 buildings in 18 months range, with a good guarantee on the coherence, accuracy and reliability of data. To achieve these objectives, only a very few number a buildings can be revisited, what should happen only in the most dramatic or suspicious situations.

There are various levels to carry out inspection and appraisal of buildings. If the main goal is general planning and strategy issues, the characterization in a general matter of the buildings in a specific zone constitutes an adequate level of inspection. But if a higher level of characterisation of buildings is pursued, then our objective is certainly more sophisticated, for example, an exhaustive and complete inspection and diagnosis must precede an individualized rehabilitation project for a valued architectural building. Then, there are various parallel levels of inspection that are specific for only some construction and material features. For example, to evaluate the structural vulnerability of old buildings, specific items must be surveyed, such as wall thickness, building hight and plan configuration, type of soil and foundations, floor slab connections to masonry walls, material shear strength, etc. The influence of such effort on the level of inspection of buildings must be justified by the degree of action of future rehabilitations carried out. In truth the level of inspection must take direct effect on the quality and depth of rehabilitation and renewal procedures.

3.1 Difficulties of the inspection and diagnosis tasks

Over 500 buildings have been already inspected in spite of several relevant, but expected, difficulties: reluctance of some tenants and home owners to opening their buildings for inspection; absence of design projects of building which would help to understand structural behaviour and to identify cracking phenomena; non-orthogonal building solutions that disturb our interpretation of the construction; physical and financial restraints to carry out more precise and conclusive inspections using destructive and non-destructive testing for the diagnosis of some defects; unknown history of undated building changes, such as the typical example of the suppression of structural elements at ground floor levels or reinforcing of slabs to achieve open-spaces for commercial activity.

3.2 Building inspection check-lists

The adopted method used in this case was tested on 75% of the buildings within the project perimeter. This diagnosis procedure shows that the inspection results quality is quite dependent on the items surveyed for each construction element (roof, façade, internal members, installation efficiency), as well as on the possibility of their correlation for a single building. The inspection and diagnosis check-lists are structured by building criteria that have been previously defined and evaluated in a hierarchy manner. Table 1 presents the purpose of the main check-lists developed within this work (see example in Figure 5). More specific check-lists were created for particular situations: buildings in ruins, abandoned or unoccupied, building renewed and transformed and building used as warehouses or commercial spaces.

Check-list	*Purpose*
A	General information of the building
B1	Evaluation of roofs and coverings
B2	Evaluation of external façade walls
B3	Evaluation of floor slabs and coverings
B4	Evaluation of interior partition walls, ceilings, windows sashes
C	Evaluation of structural quality and safety
D1	Evaluation of ventilation, salubrity and natural lighting
D2	Evaluation of thermal and acoustic conditions
E1	Evaluation of the efficiency water systems and sewerage networks
E2	Evaluation of the electrical network and telephone wires
E3	Evaluation of fire risk and security

Table 1. Main check-lists developed for detailed inspection of buildings.

The use of the check-lists enables the evaluation of the level of degradation and the systematisation of principal and recurrent defects observed in buildings.

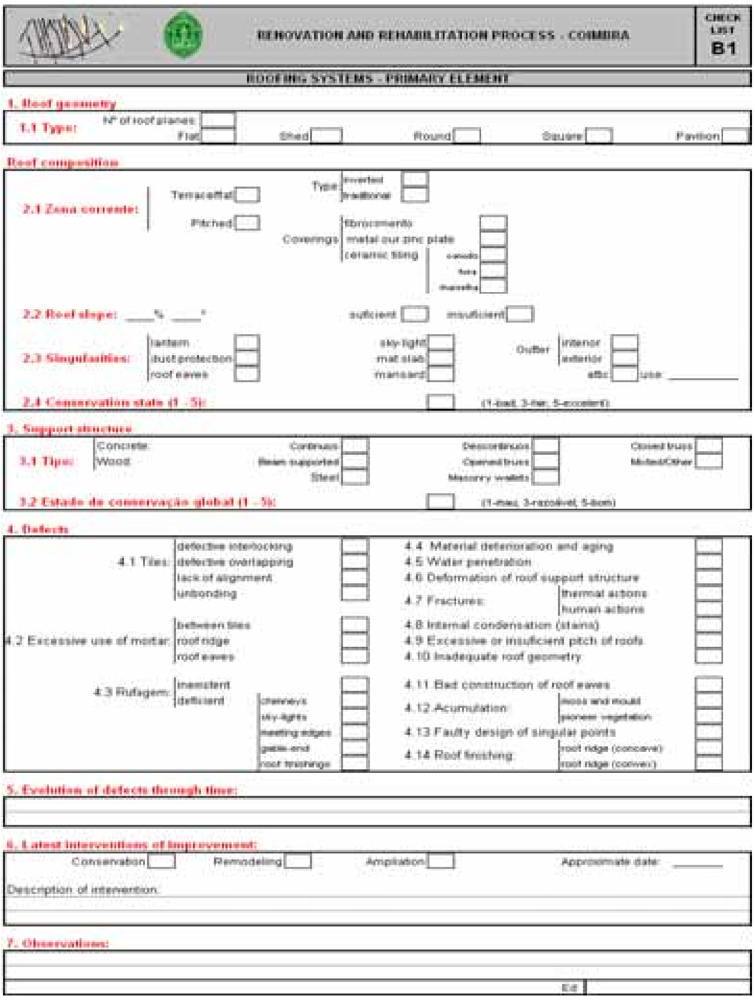

Figure 5. Example of Check-list (type B1)

3.3 Main inspection results

Roofs and masonry walls constitute the principal building envelope. Problems and defects in these elements are by far the most serious and have direct consequences on other building materials. Figure 6 presents the main results relative to roofing systems and external masonry walls on this topic:

- Cracking and disaggregating of stone masonry walls represent a significant share of masonry wall defects, affecting window openings and external renderings;
- Stains and mould growth, on exterior stone walls, caused by rising damp and rain penetration are systematically present.
- The deformation of wooden structured roof systems is one of the most frequent problems observed in roofing systems;
- Masonry wall cracking happens for various reasons but more significantly due to the concentration of stresses and crushing;
- The poor state of renderings, paint coatings and coverings of masonry walls is a very vulgar problem;
- The deterioration and aging of the materials affects all construction elements;
- Infiltrations through roofs, resulted from excessive deformation of roof support structures, or essentially, because of the non-treatment of singular roof pointing (roof ridges, corners and edges).

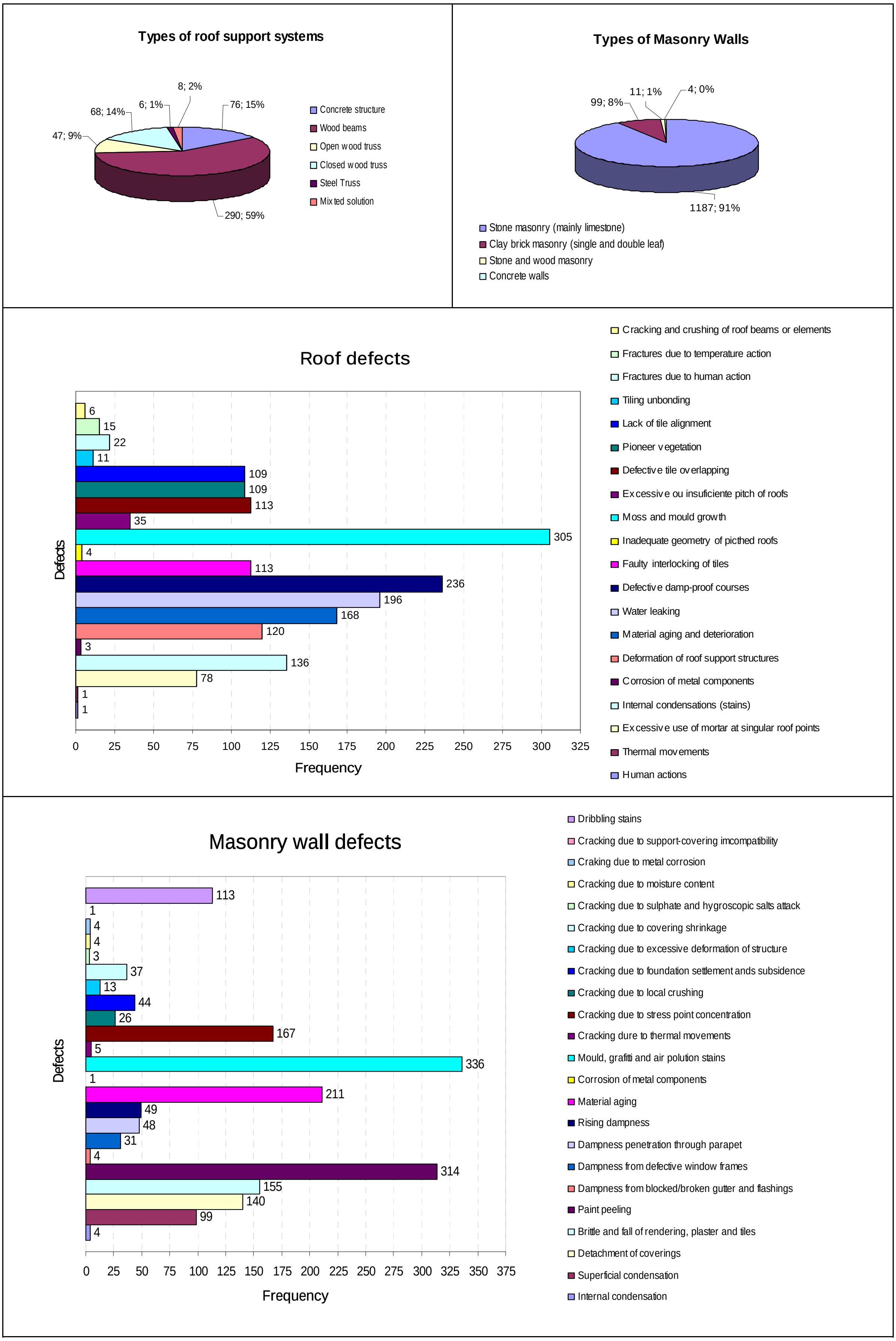

Figure 6. Inspection results for roofing systems and masonry walls

As shown in Figure 7, the conservation state of roofing structures determines the better or worse condition of other elements, such as masonry walls. Our experience reveals that the condition state of the roof reflects the rest of the construction state and could be used as a quantitative indicator in defining decision strategies and methods.

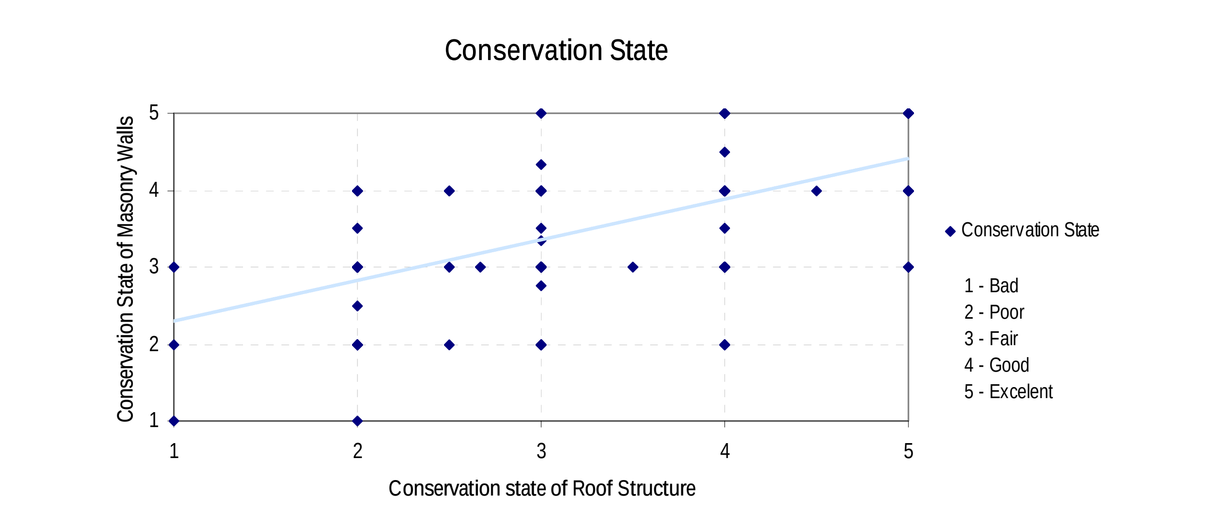

Figure 7. Conservation of roof strutures and and external masonry walls

4 CONCLUSIONS

The urge to renovate the old city centre of Coimbra is now more justified, according to the serious level of degradation observed and registered.

Urban regeneration, as a strategic activity, requires an integrated and levelled mechanism of appraisal and diagnosis as a first step. Therefore, the kind of inspection approach can determine the success and effectiveness of future stages, their feasibility and implementation of the process.

The preservation of old buildings is only a component of urban excellence, in part because old buildings enrich the historical sense, but minimal standards of comfort need to be improved by the enhancement of basic characteristics to achieve minimal standards of quality.

Further treatment of the inspection and appraisal data will allow us to develop pathology reports for buildings, list repair actions and activities and estimate rehabilitation costs. It will also help to produce defect level diagrams and seismic building risk maps, but, most important, to improve and guide a renewal strategy for downtown Coimbra.

5 REFERENCES

Appleyard, Donald (edited) 1979, *The Conservation of European Cities*, The MIT Press.

Oporto City Council 1998, *Final Report, Urban Pilot Project of Sé-Oporto*, OPorto (in portuguese).

Cabrita Reis, A.M., Aguiar, J. Appleton,1992, Rehabilitation Manual of Buildings in Bairro Alto, Lisbon, Lisbon City Council, LNEC, City Division of Urban Rehabilitation of Historic Centres (in portuguese).

Coimbra City Council Housing Department, Urban and Social Rehabilitation and Renovation Process of old city centre of Coimbra, 2003 (in portuguese).

Aguiar, J., Cabrita Reis, A.M., Appleton, J. 1998, Guide Support on Rehabilitation of Housing Buildings, Volume 1, LNEC, Lisbon (in portuguese).