



TECHNOLOGICAL ASPECTS OF PORTUGUESE MASONRY REHABILITATION PRACTICES ON HERITAGE BUILDINGS

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Abstract

The rehabilitation of buildings, specially heritage buildings, is an important aspect in the safeguard and upgrading of local environment. However, the contribution of this segment to the total construction market in Portugal is not significant when compared to the other countries of the European Union.

A case study consisting of 57 heritage projects submitted to a government department responsible for the approval and listing of these buildings allows to identify the different technological aspects of intervention in heritage buildings, namely on masonry walls. The results presented in this paper shows that the technologies used in heritage buildings are frequently similar to those adopted in new buildings, which seems to be inconsistent with a conservation technique that safeguards the built heritage.

Key Words

Masonry, rehabilitation, heritage, technologies

1 Introduction

The preservation and safeguard of existing old buildings and other buildings of cultural value should be considered of a national concern. Conservation techniques that restores their materials and components and use the technologies of the time of construction should be adopted as far as technically feasible. However, the ageing and degradation of some materials and components added to the need to make spatial and functional alterations may imply the use of varying technologies and working practices. The built heritage sub-segment and the whole R & M construction segment contributed in the last years with a very low share to the total Portuguese construction market. However, this pattern will be changing in the years ahead not only in the refurbishment of old buildings but also in the operations of urban renewal and in civil engineering works. With regard to the refurbishment of old buildings, there is a need to set up policy measures that promote an efficient functioning of this segment, including the role and

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responsibilities of different agents, particularly regulatory bodies, promoters, contractors and construction professionals.

This study presents the legal framework of the Portuguese built heritage and it describes the R & M segment within the context of the construction sector system. Secondly the trends and prospect for the R & M market are presented. Thirdly, an overview of the traditional construction practices in Portugal is presented. Fourthly, the existing practices in the R& M market are analysed, namely on masonry works. Finally, a concluding comment summarises the study and some recommendations are made.

2 Legal framework of the built heritage and the Portuguese construction system

2.1 Legal framework

The legal protection of objects of cultural value increased markedly throughout the last century in line with the international trend in this area. Thus besides the national legislation, there are also international agreements establishing conventions, recommendations and resolutions, which are applied to the country's cultural heritage. Since the last quartet of the XXst century these conventions have been translated into the Portuguese law.

The cultural value of a building is legally recognized either through its listing as historically important buildings, or through its insertion in a protected area of a listed building. Listing is a legal provision that recognizes the cultural value of a specific object which shall be subject to a special protection and valorisation.

According to the international convention (UNESCO, 1972), the categories of the listed built heritage are the following: monuments; sets of buildings; and sites, Fig.1.



Fig. 1 (DGEMN, 2004) Examples of different categories of Portuguese built heritage

Besides these categories, the built heritage is further classified according to its cultural interest or importance: national interest; public interest; and municipal interest. If a listed building in each one of the categories has a national interior interest, it is denominated a national monument.

A listed building is protected around an area within itself and extending to 50 meters from its external perimeter, which is designated as a General Protected Area (ZGP). This area may be further extended when the near urban or natural landscape is considered of architectonic significance. These areas are called Special Protected Areas (ZEP). Thus, the legal protection concerns not only the listed building but also the other buildings localized in the protected area. The aim is to preserve the image of the nearest environment of the listed building. Other areas which may subject to a legal protection are: archaeological areas; historical areas; listed streets; and ensembles (Oliveira, 2003).

2.2 Portuguese construction system

The institutional actors and the regulatory framework in the R & M construction segment are the same of those of the new construction segment.

The approval of interventions in listed buildings and other buildings located in protected areas follows a process in which the architectural design is submitted for approval in the first phase, and depending upon a positive outcome the engineering designs are subsequently submitted to the responsible entities.

Only architects are qualified to make architectural designs in protected areas and for historical buildings. The public entity responsible for the approval of these architectural designs is the Portuguese Institute for the Architectonic Heritage (IPPAR), while for other kinds of architectural designs the entities responsible for the approval of the designs are departments of Local Authorities.

In terms of engineering designs, technical civil engineers and civil engineers are the ones that are entitled to carry out these activities, irrespective of these consultancy services concern new buildings or R & M construction works. Local Authorities and departments of central government (public entities) are responsible for the approval of engineering designs and building services engineering.

With respect to the execution stage, the construction enterprises are classified as either public work contractors or private work contractors. The actors are the same for both new construction and R & M construction works, although in the case of public projects in protected areas, the construction enterprises are required by law to have a special certification (built heritage category).

The promoters of projects in protected areas are private entities, public entities, religious groups and business enterprises. With regard to the private sector promotion, the decision to enter in this market depends upon economic and financial conditions of the promoter. Financial incentives by the government are related to the type of occupation of the building after reconstruction. For example, in specific historical urban areas, there are financial programmes supported by the government for the restoration of old buildings for the rent marked segment. There is an increasing trend in the demand for buildings localised in protected areas of urban centres for the use in commerce, business services and high-standard quality housing.

3 Trends in the Portuguese M & R Construction Market

According to national statistics data (INE, 2004), the share of R & M construction works in Portugal averaged of the total market on the period, Fig.2, is the lowest value among the Euroconstruct countries, Fig.3.

However, data on awarded public work tenders (AECOPS, 2001) suggest that there has been a marked increase in R & M construction works. The share of R & M public works in total public works increased from 13% in 1993 to 26.4% in 2000. The repair and maintenance of the road network accounted for most of this increase.

A bright prospect is for the repair and maintenance segment. The recent legislative measures targeted at stimulating initiatives for the rehabilitation and modernisation of specific ageing residential parks, particularly in the metropolitan areas, added to the EU directives to lower the VAT in labour-intensive industries, will undoubtedly contribute to the development of this sub-segment of the construction market (Lopes, 2001).

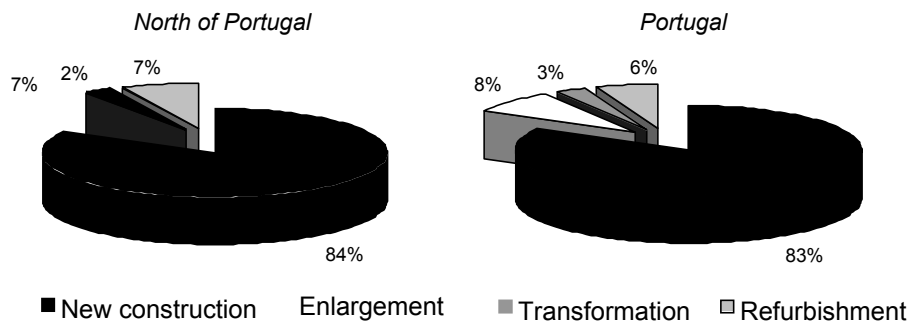


Fig.2 Share of buildings approval design projects in Portugal in 2001

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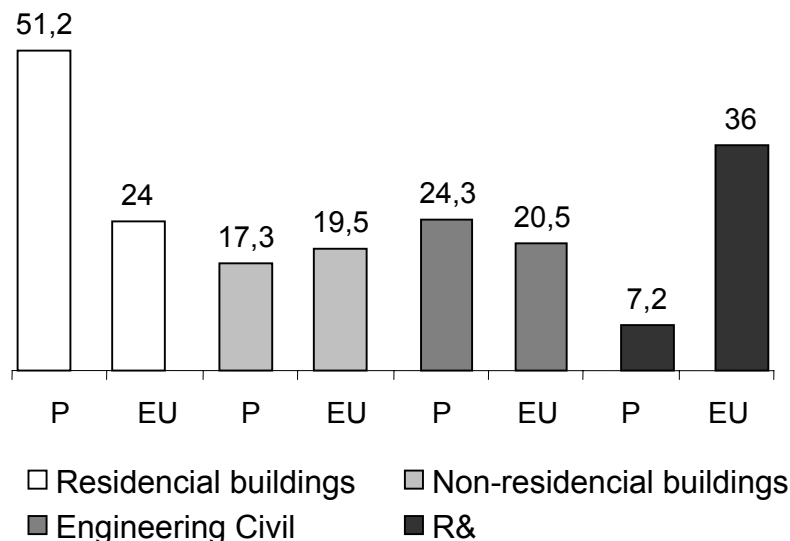


Fig.3 Comparison between new construction and R&M in Portugal and EU 1998-2000 –Euroconstruct 2001(Oliveira and Sousa 2003)

4 A brief overview of traditional construction practices in the North of Portugal

As earlier mentioned, in the past, the architecture of traditional Portuguese housing usually presented regional solutions, well adapted to climatic conditions. The use of stone in heavy and thick masonry walls was predominant in the envelope and in most important internal walls. The kinds of stone more used were the granite and schist in the north region and limestone in the centre and south regions. Except in some rustic regions or in more primitive buildings of the countryside, where the stone remained not finished, the stone enclosure walls were usually covered by a thick porous render, with low modulus of elasticity and made in multiple layers by very skilful workers. Ceramic decorative coverings and claddings, with a regional character, were used to improve

the watertightness. The partition walls were traditionally made using thin wooden elements plastered with hydrated lime mortar, but have been progressively replaced by thin clay brick walls.

Floors were usually made of timber beams and wooden floor, Fig.4. Roof structures were generally also in wood and covered with ceramic tiles.

By the end of the 1940s building solutions and technologies evolved markedly, and the traditional practices have progressively replaced by new ones, not always adapted to local conditions as in the previous buildings. Particularly in urban regions, the use of concrete structures have become widespread, first on the floors replacing timber, being progressively extended to the vertical support elements. By then, the walls lost their structural role and became only infilling elements, and the stone has been replaced by clay bricks. Clay brick producers developed a multitude of shapes, but always progressing from solid to large horizontally perforated elements, Fig. 5.



Historic Center of Porto



Building in demolition

Fig.4 Typical traditional Portuguese building



In construction



Finished

Fig.5 Current Portuguese building after widespread use of reinforced concrete

5 Actual M & R construction practices in the North of Portugal

5.1 Introduction

This section presents some results of a case study that was undertaken between April and July 2002 on heritage building projects, which were submitted to the public authority responsible for the approval of this kind of construction projects. The aim was to investigate the materials and components used in reconstruction works, as well as

the technologies adopted in restoration/substitution of materials and components. The analysis comprised a study of 52 building projects in protected areas and 5 listed building projects. The geographical area covered in the study is the north region of Portugal and the regulatory authority is the Porto Regional Directorate of IPPAR.

The choice of the sample was made in a random and sequential form and was independent of the decision of the regulatory authority on the projects designs. For reasons of confidentiality, the names of the promoters and construction professionals participating in the projects are not stated.

The variables which were analysed are: type of occupation before and after reconstruction works; architectonic value; kind of intervention; typology of the building; level of detail of the design and characteristics of architectural and structural materials and components. The architectural and structural components were analysed according to their conservation status, and their similarity in case of the substitution of the existing ones. The level and quality of the information reported on the buildings design has been also analysed and the results are summarised in Fig.6.

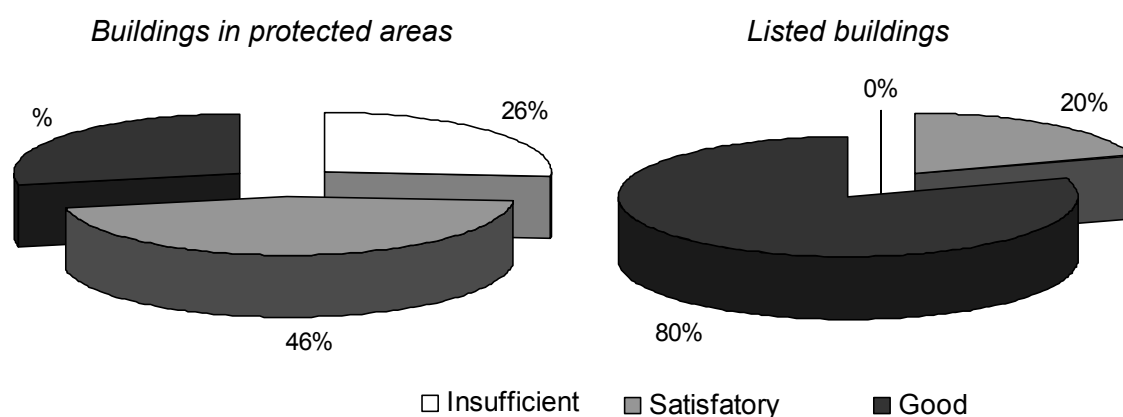


Fig.6 Quality of design information

5.2 Building projects in protected areas

Most part of the buildings was in an advanced stage of degradation, without safety conditions for the users and some of them were vacant. The occupation before reconstruction was, mainly, for housing and, in some cases, for mixed use of housing and commerce. As is shown in Fig 6, the pattern of occupation after reconstruction was diversified and some of the buildings were simultaneously occupied for housing, commerce and services. This significant use of the buildings for the service sector is an indication of the attractiveness of these buildings in protected areas.



a) Religious cult; b) housing and commercial buildings; c) commercial buildings; d) housing; e) stores; f) vacant; g) tourism, hotel; h) housing, commercial and service buildings i) commercial and service buildings; j) housing and service buildings. k) service buildings.

Fig.6 Buildings occupation before and after rehabilitation

With respect to the conservation and rehabilitation of structural elements, Table 1 summarises the results of the analysis according to the information of the project designs.

In the situations where it is supposed either to preserve partially or not to preserve structural elements, Table 2 summarises the intention of using materials and solutions similar to the previous ones.

Table 1 Preservation of structural elements in rehabilitation interventions according to design proposals

Structural element	Preserved		Not preserved (%)	Not defined (%)
	Totally (%)	Partially (%)		
Floors	8	4	73	15
Roof	16	2	65	17
External Walls	57	24	10	9
Stairs	8	-	20	72

Table 2 Similarity between new and existing solution on rehabilitation design proposal

Structural element	Similar		Different (%)	Not defined (%)
	Totally (%)	Partially (%)		
Floors	4	4	78	14
Roof	55	3	35	7
External Walls	30	45	20	5
Stairs	2	2	11	85

Reinforced concrete is the main building material used in the structural components, mainly in floors and columns. The roofs are made mostly from a timber structure. There is, in a significant number of projects, no detailed information regarding the structural components.

5.3 Listed building projects

As earlier referred the sample is very small, which is consistent with the small number of intervention (as far as existing architectural designs are concerned) in this type of buildings. Note that most important listed buildings are not subject to significant architectural modification. The occupation after rehabilitation is aimed, for all the buildings analysed, at the tourism and hotel sectors. This is related to the financial incentives from the government to stimulate cultural tourism in the countryside. Another important aspect to be noted is that there are no financial incentives with regard to the works aimed at their future occupation for housing.

As it would be expected in this kind of projects, there seems to be a greater concern for the restoration of structural elements, particularly external walls, floors, roofs and stairs. The pattern with respect to the structural materials adopted in reconstruction is similar to those used in the building projects in protected areas. Tables 3 and 4 summarises the results of the different structural elements used in the interventions.

Table 3 Design proposal of preserving structural elements on rehabilitations interventions in listed buildings

Structural element	Preserved		Not preserved (%)	Not defined (%)
	Totally (%)	Partially (%)		
Floors	40	20	20	20
Roof	20	40	40	-
External Walls	60	20	20	-
Stairs	40	20	20	20

Table 4 Similarity between new and existing solution on rehabilitation design proposal in listed buildings

Structural element	Similar		Different (%)	Not defined (%)
	Totally (%)	Partially (%)		
Floors	67	-	-	33
Roof	100	-	-	-
External Walls	50	50	-	-
Stairs	-	33	-	67

5.4 Masonry walls solutions

In what concerns external masonry walls, a more detailed analysis has been carried out. Special attention has been paid to the state of the masonry walls before intervention, and to the walls materials used before and after rehabilitation, Tables 5 and 6.

Table 5 Quality of the external masonry walls before intervention

Level	Buildings in protected areas (%)	Listed buildings (%)
Good	35	60
Reasonable	33	40
Degraded	6	-
Without information	26	-

Table 6 Materials used on external masonry walls

Materials	Buildings in protected areas (%)	Listed buildings (%)
Granite	65	100
Schist	4	-
Ceramic Brick	4	-
Miscellaneous	20	-
Without information	7	-

With the available information reported on the project designs, it is not possible to know the extent to which the contribution of the walls was considered in the structural analysis, but according to some visits made by the authors to the construction sites, Fig 7, it is reasonable to assume that only in few cases a modern structural analysis of the masonry is made. Frequently, the structural design is made taking only into account the same practices used in new concrete frame structures.



Solar Pimenteais, Mogadouro



Solar Village Vilar

Fig.7 Example of works on site in a building rehabilitation

6 Conclusions

This study has presented some results of a case study conducted on 57 built heritage projects submitted to a regulatory authority responsible for the approval of this kind of construction projects. In addition, a description of the main institutional actors, and a prospect of the development pattern of the Portuguese R & M market have been presented. The share of this market segment in Portugal is not significant when compared to the other countries of the European Union but the prospect is for a marked growth in the years ahead due to the ageing of residential parks and policy initiatives to stimulate the rent market. The increasing concern for the safeguard of heritage buildings adds to the situation.

Some results can be presented regarding construction practices in protected areas in Portugal:

- There is a concern for the part of the regulatory authority to enforce the preservation of the façade of buildings with respect to materials and colours, but no special care is taken with regard to the internal components;
- The surveying and diagnosis of the structural components, as well as their conservation status are not a common practice for the part of the architectural firms;
- The restoration of degraded components and their substitution by similar materials are not a privileged practice in the rehabilitation of buildings;
- The level and quality of information in the architectural designs is very variable, and there is a lack of detailed information regarding the structural elements;
- External masonry walls are one of the most preserved components, but only in few cases the structural analysis take into account, according modern practices, of the walls contribution;
- There is a lack of knowledgeable professionals, in all stages of the construction life cycle, to carry out activities concerning construction projects in protected areas and listed buildings.

Some practical recommendations, consistent with the analysis presented here, are thus stated:

- Construction professionals should endeavour to have an approach to buildings in protected areas and listed different than that they have normally to new constructions. The development of integrated solutions with regard to the structural elements, materials and components seems to be the way forward;
- In addition, the control and supervision of works should be strengthened so as to comply with the prescription of the architectural designs approved by the regulatory entity;

- There is a need for the part of the construction enterprises to invest in the professional training of their employees. The acquisition of new equipments and tools suitable for the intervention in the built heritage market is also needed.
- The policy initiatives and financial incentives target at stimulating the built heritage market sub-segment should be strengthened.
- Some guidelines and other technical support documents helping construction professionals to approach the design of these buildings are needed. In masonry walls, those practical guidelines with references to survey, diagnosis, design, structural analysis and rehabilitation techniques are especially needed.

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