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Pathology, diagnosis and repair of pitched roofs with ceramic tiles: Statistical characterisation and lessons learned from inspections

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HIGHLIGHTS

- Expert-knowledge system on pathology, diagnosis and rehabilitation of pitched roof claddings.
- Statistical data on the pathology (anomalies and causes) of pitched roof claddings.
- Statistical data on the use of diagnosis methods in pitched roof claddings.
- Statistical data on the rehabilitation of renderings.

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ABSTRACT

This paper presents an expert-knowledge inspection and diagnosis system for pitched roofs with ceramic tiles and reports a statistical characterisation of the pathology of 62 roofs. It also identifies the diagnosis methods that may be used to characterise the anomalies and confirm their most probable causes, as well as the best repair techniques. A detailed correlation between anomalies and causes is also established. For the first time in the literature the pathologies of ceramic tile pitched roofs are characterised using quantitative indicators based on a statistically significant sample.

1. Introduction

Roof claddings are one of the most relevant non-structural elements of a building. Anomalies in these elements may lead to structural problems in the roof itself and in the rest of the building, and also damage the furniture and goods inside. As in southern Europe in general, ceramic tiles are the most popular pitched roof cladding solution in Portugal, being used in almost 90% of pitched roofs (ECPR – external claddings of pitched roofs) [1]. This has been the theme of many studies published in Portugal, given its importance in terms of built heritage [2–4]. However, there is no literature that analyses and characterises the pathology of the external ceramic claddings of pitched roofs (ECCPRs), using quantitative indicators supported by a statistically significant sample.

To bridge this gap this paper presents a ECCPRs inspection and diagnosis system and the statistical analysis of the relevant field work, comprising the anomalies, the diagnosis methods used to characterise them and confirm their most probable causes, as well as the appropriate repair techniques. The most important lessons learned from this field work, which comprises a standard inspection programme of 62 ECCPRs, are summarised here. These lessons can be useful to designers and contractors, in order to avoid recurrent in-use defects, building owners, in order to be positively critical in their appreciation of design and building plans and tenders, maintenance and rehabilitation firms, in order to plan their activities within the frame of a pro-active strategy.

Given the academic non-funded nature of this work the diagnosis methods and repair techniques were not actually implemented, they were simply prescribed.

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2. Characterisation of the sample

The sample analysed consists of 62 ECCPRs (30% of the universe inspected, consisting of 207 ECPRs of various types of roof claddings – ceramic, micro-concrete, fibrocement, natural stone, metal, plastic and composite) in 59 buildings, with a grand total of 426 anomalies detected. 616 Repair techniques were prescribed on site, i.e. an average of 1.45 techniques per anomaly, as were 542 diagnosis methods, i.e. an average of 1.27 methods per anomaly.

2.1. Characterisation of the sample according to the type of ceramic tile

The sample included the main types of ceramic claddings, of which 34% used *Lusa* roof tiles, 32% used *Marselha* roof tiles and the remaining 34% were made of *Canudo* roof tiles (Fig. 1). Both Roman and plane roof tiles were left out because of their low significance at national level.

The roof tile types analysed in this study are illustrated in Table 1.

2.2. Geographical distribution of the sample

The inspection plan was devised in order to select a representative sample of the main ECCPRs used in Portugal. It was based mostly on current buildings, in the centre (Lisbon and Tagus Valley) and north (Porto) regions, mostly in rural and urban surroundings. Fig. 2 illustrates the geographical distribution of the sample.

2.3. Age distribution of the sample

Buildings are classified as recent if they were built after 1945 [1]. In fact the roofs inspected are mostly recent, as seen in

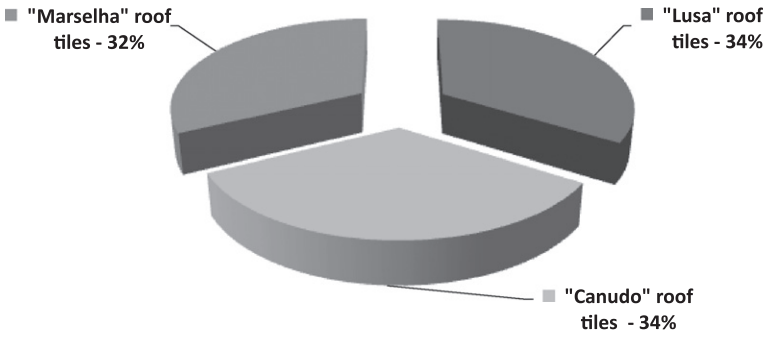
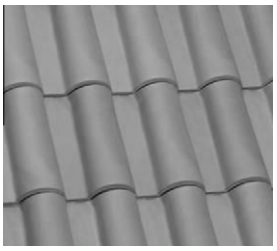
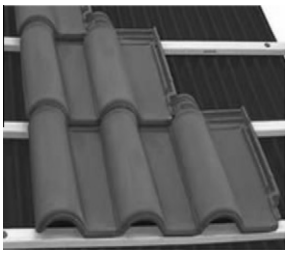
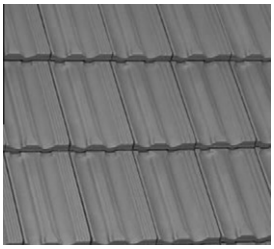


Fig. 1. Sample characterisation in terms of type of ECCPR.

Table 1
Types of ceramic roof tiles in Portugal.

Lusa roof tile			
Marselha roof tile			
Canudo roof tile