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DEVELOPMENT OF METHODOLOGIES AND PROCEDURES FOR ENERGY DIAGNOSIS OF EXISTING RESIDENTIAL BUILDINGS

Ana Novais¹, Manuela Almeida² and Rui Lopes¹

¹Rua Major Miguel Ferreira, n.º 50, Fafe, Portugal

²University of Minho, Civil Engineering Department, Campus de Azurém, Guimarães, Portugal

E-mail: margarida.engenharia@gmail.com

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ABSTRACT

In the last decades we have seen the raise in energy use originating the increase of greenhouse gases emissions and the consequent climatic changes we all assist. It is therefore important to develop strategies in order to reduce energy use, especially in buildings once they are responsible for a large amount of energy consumed. Since only recently sustainability and energy efficiency issues have gained special relevance, there is a great potential for the development of methodologies and strategies to improve the energy efficiency of buildings and to diagnose and repair thermal pathologies. This work intends to characterize the thermal performance of residential buildings identifying their main thermal pathologies resulting from a bad design of the envelope and proposing the most suitable improvement measures to reduce or eliminate these pathologies. To achieve these goals, a thermal diagnostics software tool is being developed taking into account the analysis of the envelope, the HVAC systems and existing pathologies. This tool will help designers to define their rehabilitation strategies towards improved buildings energy performance in a cost/benefit perspective.

METHODOLOGY OF THE STUDY

To develop the software tool, an initial analysis was undertaken to assess the state of the art regarding the characterization of the existing housing stock and that consisted of a collection that included the exhaustive literature review of the different types of residential buildings as well as the solutions used to characterize and standardize the existing residential buildings. Based on information gathered within the literature review, it was decided to divide the thermal pathologies encountered in four major groups: pathologies in facade

elements, in roofs, in floors and in glazing. Each of these groups then originated subgroups with the most frequent pathologies. Each of the pathologies observed was recorded as well as the improvement measures proposed to eliminate it. During the study, it was performed a detailed cost-effective analysis of the proposed rehabilitation solutions based on inflation and interest rates. The study also included the assessment of the asset value achieved in the building with the rehabilitation process, along with a detailed cost analysis of each task towards the objective. Since 2009 they were reviewed more than 600 buildings.

RESULTS

Characterization of Thermal Pathologies

Although the sample included relatively new buildings in their distribution (with 37% of the buildings built after 2006 - date of entry into force of the renewed thermal regulation, and 76% of the buildings built after 1990 - date of entry into force of the first thermal regulation), it is verified that the Portuguese housing stock shows large gaps in its thermal quality. Indeed, a large part of the buildings studied exhibit degradation in its coverings with the presence of humidity in the walls (48%), roofs (25%) and floors (9%). This is due mainly to lack of insulation in these elements (35% in walls, 49% in roofs and 61% in floors) and the existence of thermal bridges in walls (53%). In the case of glazing it was possible to see that the pathologies found are mainly due to the use of single glazing with low thermal performance (39%) instead of double or triple glazing with better performances.

Improvement measures Proposed

Each one of the pathologies observed in the 600 analysed cases was recorded as well as the improvement measures proposed to eliminate them. As it is possible to see, in most cases the proposed improvements encompassed the placement of insulation in the



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envelope elements, especially on the roofs (71% of cases). These measures allowed not only to improve and eliminate the most common pathologies (presence of humidity and degradation of the coverings), but also reduce the heat losses through opaque envelope. It was also given particular attention to equipment for heating DHW (62% of cases) given its importance in energy consumption in households having to bet on the placement of more efficient equipments.

Thermal Diagnostics Software Tool

The difficulty shown by stakeholders in the process of energy certification of existing residential buildings in analyze the most appropriate improvement measures to thermally rehabilitate a buildings and reduce or even eliminate their thermal pathologies, allowed the development of a software tool that makes this process easier. The software will analyze the current state of a building based on a dimensional assessment and characterization of all elements of the envelope (walls, roofs, floors, windows ...) and the characterization of the pathologies found. This initial analysis will also include the study of the building energy performance as well as the determination of the asset value of the property before any measures are implemented. Based on this information, the tool will then propose the most appropriate measures to improve, both technically and economically, its thermal behavior. The building energy performance and the asset value of the property will then be re-evaluated with the improvement measures implemented. This economic analysis will evaluate not only the decrease in energy costs but also the increase of asset value, taking into account current interest rates.

CONCLUSIONS

By the analysis so far, it is possible to conclude that, in existing buildings, thermal bridges in façade elements are very frequent and responsible for humidity and moisture problems and degradation of the coverings. Insufficient insulation of roofs and floors are also common situations detected responsible for the very poor thermal performance of existing buildings along with the poor quality of glazing that, in most of the situations, are single glazing. It is noted that in the studied sample, most of the observed fractions belong to relatively recent buildings (39% between 1991 and 2006 and 37% after 2006). The data shows that the entry into force of the new thermal regulation, RCCTE, dated from 2006, has not yet been fully assimilated by some

of the players, especially those responsible for construction. Too often it appears that buildings constructed after 2006, but before the entry into force of the SCE (Building Energy Certification System), do not meet the minimum requirements imposed by the thermal regulation, thus not complying with the requirements of the projects. In addition, it appears that designers have some difficulties in analyzing the most appropriate measures to improve the energy performance of a building largely due to the lack of experience, technical studies and regulations in this area. For these reasons the tool that is being developed is particularly important in the Portuguese context. It is intended that the use of it would not only facilitate the work of designers but also raise the technical quality and efficiency of energy rehabilitation performed allowing to population greater comfort in their homes and notably reducing unnecessary energy expenditure.

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AUTHORS' BIOGRAPHIES



ANA NOVAIS was born in Fafe, Portugal, in 1983. She has a degree in Civil Engineering by Minho University (2006). Since 2008 she is a PhD student at Minho University developing a PhD thesis entitled "Development of Methodologies and Procedures of Energy Diagnosis of Existing Residential Buildings".

MANUELA ALMEIDA is Associate Professor at Minho University. She has a PhD in Mechanical Engineering (1995) at the University of Porto.

RUI LOPES has a degree in Civil Engineering by Porto University (2001) and he is managing partner of Ambiestudos – Ensaios e Análises Ambientais, Lda.