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The attic and its effect on the energy performance of historic buildings

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Abstract

This paper aims to investigate the problem of attics conservation or dismantling from historic buildings. The attic, unconsciously inherited and planned with the traditional building techniques, constitutes a precious architectural heritage in the field of historic housing in the whole European patrimony. In many cases, the peculiarities of the type of techniques and the use of traditional local materials are the reasons why attics constitute an evidence of an active culture of know-how that has to be preserved. Furthermore, the attic-mediated heat transfer between indoor and outdoor environments, contributes to the saving of building heat loss. Nevertheless, the practice of eliminating attics is particularly diffused, and building owner or architects, preferring to dismantle their structure, compensate this loss by using insulating boards to constitute the final roofing section.

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1. Introduction

Studies on local materials and construction techniques constitute a complex heritage of knowledge and expertise. This kind of patrimony converts the empirical know-how, which characterize past populations and places, in technical culture. Since time immemorial, the selection of the construction material is connected with its availability, its manageability, its resistance to natural and human induced decay, and, most importantly, the climatic context.

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Frequently, constructive technologies and modern materials selected for interventions aimed at monitoring energy consumption of an ancient building, are in contempt of the traditional building techniques. Furthermore, the global improvements in terms of performance, compared with the starting conditions, are not always achieved.

Ceilings (or false-ceilings) elimination and the loss of attic as a typological peculiarity of some historic buildings is a common practice in Italy, where roof transmittance is, instead, improved by a covering thickening, made by the addition of insulating layers. This procedure not only involves an increase in the net volume air-conditioned space, but also determines the loss of precious information about the original constructive characteristics of the building, and the different materials and techniques employed to create the authentic language of the local building tradition.

The ventilated roof is nothing but the translation of the old attic, constructed with the modern green buildings techniques. The attic ventilated and cooled the building during the summer, when the windows were left open, while insulated during the winter, when the windows were left closed. The air chamber, enclosed in a ventilated roof, acts as a climate filter towards the outdoor environment, allowing the intrados of the ceiling to remain fresh in order to make comfortable the use of attic.

Currently, the insulation of the building envelope represents the main strategy to control energy consumptions, during both winter and summer, without taking into consideration the characteristics of the climate. According to D'Orazio et al. [1] this approach is responsible for the spread of construction technologies and materials that do not adhere to the traditional construction methods. Additionally, excessive insulation of buildings raises the risk of reducing the effectiveness of passive cooling strategies (thermal mass, roof ventilation) and could have undesirable effects on the indoor comfort.

The strategy of attic ventilation is one of the most widespread techniques to reduce the accumulation of heat in the interior spaces of a building. According to the studies of Karam Al-Obaidi [2] the benefits of ventilated attic consist in the possibility of controlling the high levels of energy consumption. Furthermore, the influence of ventilated attic on the building thermal performance has been studied by Dimoudi et al. [3] who demonstrated the effectiveness of the ventilation (and radiant barriers) in the roof in reducing solar heat gain during the summer.

The need to properly calibrate the size and the placements of the insulating layers on the roof has been stressed by the study of Ozel and Pihtili [4] on the effects of the addition of one or more levels of insulation on 12 different configurations of the roof. They claim that the best solution is to place three pieces of insulation of the same thickness, one on each side and one at the center of the roof. The same topic has been studied by Ben-Nakhi et al. [5], leading to the conclusion that it is possible to save energy only when the insulation is properly positioned.

Nomenclature

V	Volume
S	External Surface
H	Heat Transfer Coefficient
$_D$	Direct heat transfer
$_U$	Unconditioned spaces
$_R$	Roof
$_W$	Wall

2. Goals

The aim of our research is to study the thermal influence of the attic on ancient buildings. In particular, we seek to evaluate circumstances in which attic conservation or elimination is preferable. We compare two case studies, representing two models of the same house, one with and one without attic, in terms of global heat loss values. We calculate the respective values of H, heat transfer coefficient, intended as the sum of H_T, transmission heat transfer coefficient, and H_V, ventilation heat transfer coefficient. In particular, we evaluate in what way and how much H value varies as a function of the physical quantities that influence the heat transfer coefficient amount, together with the conditions, linked to particular transmittance values, volumes or external surfaces building elements, that determine that the heat loss of the first case study to be greater or lesser than the second one.