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Thermal and acoustic performance evaluation of new basalt fiber insulation panels for buildings

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Abstract

Thermal insulation of building envelope is very important in energy saving: a growing interest is focused on using insulating recycled and sustainable materials. The thermal and acoustic properties of innovative basalt natural fiber insulating panels were investigated. The thermal conductivity was evaluated by means of a Heat Flow meter apparatus: it is included in 0.030-0.034 W/mK range. The acoustic absorption coefficient was measured by means of Kundt's Tube. The results were compared to traditional solutions with similar chemical composition, but worse mechanical resistance. The easy application of this solution could be useful especially for refurbishments.

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Keywords: basalt fiber insulation panels; thermal performance; acoustic performance; Kund's Tube; refurbishment of buildings

1. Introduction

Thermal insulation in buildings contributes to reduce the size of air-conditioning systems and the annual energy consumptions. The periods of thermal comfort could be extended without depending on mechanical air-conditioning systems, especially during inter-season periods [1]. In Italy at least 90% of buildings were constructed before 1991 and the most part is not in compliance with the statutory requirements (the most recent norms date 2006). The application of innovative solutions can be a useful tool for the refurbishment of existing buildings, reducing the envelope heat losses . Optical, thermal and acoustic properties of innovative insulating systems for buildings have

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been investigated at the University of Perugia since 2003, both with experimental campaigns and simulation codes [2, 3, 4]. The application of innovative insulating systems composed of basalt natural fibers can be a clever solution for decreasing heat losses. Basalt fiber combines ecological safety, natural longevity, and many other properties, such as mechanical strength and thermal insulation characteristics. It is not a new material but its applications are surely innovative in many industrial fields, in particular for buildings, constructions, and energy efficiency. The present study is focused on thermal and acoustic characterization of insulating panels composed of basalt natural fibers. Three panels different for density (145, 175, and 200 kg/m^3) and thickness (9 mm, 18 mm, and 27 mm) were investigated. The thermal conductivity was measured by a heat flow meter apparatus at the Labs of the Agosti Nanotherm Company. The tests for the evaluation of the normal incidence acoustic coefficients were carried out at the Labs of Building Physics of the University of Perugia.

2. State of art of basalt fibers insulation panels

2.1. Materials and applications

Basalt is a variety of volcanic rock, especially known for its resistance to high temperatures, strength, and durability. It is suitable for applications requiring resistance against high temperatures, insulation properties, acid and solvent resistance, durability, mechanical strength, low water absorption, etc. In particular, basalt fibers can be used for fire protective applications; it is also an eco-compatibility material, characterized by an easier recyclability when compared to rock or glass fibers. Furthermore, basalt fiber technology production is similar to glass fibers one, but it requires less energy. The large availability of raw material all over the world allows lower costs when compared to glass fibers. Basalt fibers are produced from basalt rock by using single component raw materials and by drawing and winding fibers from the melt. Once the basalt fibers have been produced, they are converted into a suitable form for particular applications [5].

The paper is focused on insulation basalt fiber panels as innovative materials for high energy efficiency in buildings (Fig.1). The chemical composition of the investigated samples shows a high percentage of alumina; it is completely composed by natural fibers, without additives. In this case, in particular, all the mineral fibers used for the construction of the panels are 100% recycled. These systems have a high mechanical resistance, excellent thermal and acoustic properties, and good breathable properties. They are available in different densities and thicknesses. Usually they can be applied as internal coatings, they can be glued to a wall surface and daubed with plasters or paints, without using reinforcing-mesh.

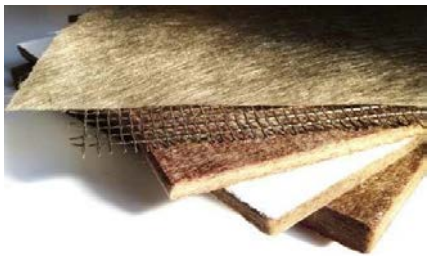

Fig. 1. Basalt fiber insulating panels.

2.2. Description of the samples

Square samples were realized for thermal characterization. They were assembled with external dimensions 300 x 300 mm (dimensions of the experimental apparatus). Three panels different for density were investigated (145, 175 and 200 kg/m^3). The names of the tested samples and their characteristics are reported in Tab. 1: only the panels with a total thickness of 9 mm were tested considering the three different densities (BF_9_a, BF_9_b and BF_9_c).

For acoustic tests, cylindrical samples with diameters 29 and 100 mm were manufactured. Three samples with different thicknesses (9 mm, 18 mm and 27 mm) were investigated: the densities of these samples are not uniform