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Use of agro-wastes in building materials in the Mediterranean area: a review

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Abstract

In the recent years, the environmental issues i.e. pollution and energy consumption foment an increasing interest and the resulting regulations led the construction field to focusing on the thermal insulation. The insulation materials commonly used in building constructions are mainly realized using non-renewable materials and this provoke problems in reusing or recycling the products at the end of their lives. Moreover, the production of these materials often requires high-energy consumptions. The development and the application of bio-based insulation materials can contribute to minimize the environmental impacts of buildings reducing the energy demand both during the construction and the use. For this reason, these kinds of materials are developing very fast, although they are still at a very early stage. Among the biomasses used, the agro-residues can have an interesting role because their use allows the revaluation of agricultural wastes, whose disposal is another serious issue. This work aims to report a state of the art of some building insulation products available in the Mediterranean context made of agro-wastes such as cereal straw, hemp and olive waste.

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1. Introduction

The European Commission [1] estimates that Italian buildings consume about 30% of the global energy and produce about 15% of the CO₂ emissions. The improvement of the thermal performances of existing and new buildings can contribute to reduce the heating and cooling demands in order to get energy savings.

On one side, the interest on building materials with vegetable fibers has raised in the last years also due to the world economic crisis that causes the overturning of the current thought.

On the other side, the social progress and the global development have led to increase the people's demands on indoor air quality, reducing meanwhile the energy consumption [2].

Liu et al. [3] assert that depending on the raw materials the common insulations can be classified into four categories: (1) from rocks and slags, such as rock-wool, glass-wool, expanded perlite, glass beads, vermiculite, cinder, ceramic products, etc.; (2) from petrochemical and coal chemical intermediate products, such as Polystyrene, Polyurethane, Polyethylene, etc.; (3) from plants, including agricultural waste, forestry waste and industrial plants fiber waste, such as straws, rice husk, waste papers, wood shavings, cotton, corn crops, etc.; (4) from metals, such as metal reflection film, hard metal visor, radiation plate, etc. These latter applications are still limited because they can only be applied in roofs and they are much more expensive than other thermal insulation materials.

Asrubali et al. [4] describe the state of art of the sustainable building materials taking into account the unconventional materials and dividing them in two classes: natural and recycled.

It should be note that commonly used materials, such as mineral wool and plastics can cause environmental issues due to the use of non-renewable materials, and to the disposal phases at the end of their lives.

Thus, one of the preferred way to realize insulating materials is using natural raw materials and reusing local agro-waste for producing panels, plaster, blocks suitable for the passive houses[5- 10].

The introduction of the concept of “sustainability” in the building sector gradually led to the production of insulation products made of natural or recycled materials; some of them are already present in the market while others are still at an early stage of production or study [4]. However, it must be considered the solving problem of the disposal of agro-wastes. Crop residues represent more than half of the world's agricultural phytomass [9]. Such residues are generally left and burned in the fields. Lozano et al. [9] have shown the use of the residues for producing energy and biomass.

Liu et al. [3] show the potential use of the agricultural waste in the building field: solid boards/panels (including block types), raw biomasses, multi-layers (including sandwich types), filled loosen/foaming types, particles, slurry types, coil, etc. Bories et al [10] examining the use of the biomass for the fired bricks demonstrate the significant enhancement of the thermal properties.

However, according to Kymäläinen et al. [11] bast fibers as a natural resource have a risk for microbial and other contaminants, and their quality should be monitored regularly.

Careful procedures during harvesting, processing, manufacturing, building are required in order to avoid the risk of negative effects (i.e. molding) caused by moisture and free water. Furthermore, the development of fibrous thermal insulations needs the use of additives that are to be controlled in order to avoid negative effects on indoor air quality.

This study can help to have a more precise comprehension about agro-waste research status in building field, demonstrating the potential energy improvement caused by bio-based building product. The authors have analyzed the hygrothermal properties of the insulating materials focusing in particular to the main vegetable fibers present in the Mediterranean area: hemp, straw and olive waste.

2. Hygrothermal properties

Different requirements such as thermal, mechanical, acoustic, hydraulic and economical have to be satisfied when considering a building materials.

Liu et al. [3] demonstrate that the thermal performances (thermal conductivity, thermal diffusivity, heat capacity) are the main properties investigated in the recent researches (Fig. 1). This is due to the need to reply to one of the main issue of the environment: the reduction of the energy consumption.

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