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ANALYTICAL REVIEW OF THE MYCELIUM-BASED MATERIALS TO APPLY IN CONSTRUCTION INDUSTRY

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Introduction. In the last decade, supplies of traditional building materials such as cement, bricks, wood, cladding and partition materials have sought to keep pace with the ever-growing global population [1]. Up to 36 % of the lifetime energy intensity of a typical dwelling can be attributed to the collection or extraction of primary materials, the production, transport and construction of buildings [2]. Modern energy-efficient buildings, although sustainable during the exploitation phase, are not environmentally friendly due to the construction process requiring an increased level of insulation and higher density materials, as well as additional technologies [3].

A new form of low-energy biological production and waste recycling is the vegetative growth of fibrous fungi (mycelium). Mycelium-derived materials have several key advantages over traditional synthetic materials, including their low cost, density and energy consumption, as well as their biodegradability, low environmental impact and low carbon footprint. A wide range of usable substrates, together with controlled processing techniques (e.g. growth media and hot pressing), allow mycelial-derived materials to meet specific structural and functional requirements, including fire resistance and thermal and sound insulation. These materials use the natural growth of fungi as a low-energy method of organic production to recycle abundant agricultural by-products and waste into more sustainable alternatives to energy-intensive synthetic building materials.

Current research on mycelium-based materials lacks basic details regarding material composition, incubation conditions and production methods, as well as an analysis of the prospects for its use and wide application in the construction industry for zero-pollution buildings, facades, insulation, interiors as well as heritage restoration.

Research purpose. Analyzation of the available mycelium-based materials and their applicability for sustainable building design with the zero-pollution effect.

Findings. The choice of building materials is a critical point for sustainable building design. It has a significant impact on the sustainability of the building at all stages of the life cycle. The right materials should respond to a list of basic criteria that aim to ensure not only energy efficiency but also a healthy indoor climate, thoughtful recovery and recycling potential. The environmental aspect of building design has a complex structure consisting of assessing the impact on the global environment and on the person, who operates the building in a local environment. During the design process, it is very important to consider the building material not as a final product, but to take into account all phases of the operation of the building material.

Natural materials are materials that have not been industrially processed. However, the implementation of a complete building design in 100 % organic-based materials without industrial processing is not realistic in practice. It should be taken into account that any process of industrially influencing originally natural material, such as wood or straw, will remove it from nature. The design of a building from ecological materials is therefore a search for the most effective techniques for the selection and processing of natural raw materials, taking into account the need to minimize the industrial impact on them and maximize the use of their original positive properties [4].

The world's population is expected to reach 9.8 billion by 2050 [5]. The rapidly growing population also results in growing demand for food and increased agricultural production, leading to the generation of agricultural waste such as various types of straw. Low-value agricultural by-products and wastes have limited uses and their primary uses are fertilizers, animal bedding and fillers for building materials [6].

The renewable and closed-loop composites are composed of fungal biomass and lignocellulosic waste streams. The hyphae of the fungus form an interwoven three-dimensional filamentous network through the cellulose, hemicellulose and lignin rich substrate by digesting its nutrients and simultaneously binding the substrate. When reaching complete substrate colonization, the organism is heat-killed above a critical temperature to render the material inert and allow the evaporation of the residual water from the material. The result is a lightweight and bio-degradable composite with a low environmental impact (Fig.1) [7].

Fig. 1. Example of lightweight and bio-degradable composite on the base of mycelium [8]

The analyzed research outcomes [9−11] showed that the feedstock of the composed materials based on mycelium has a critical influence at the mechanical and heat engineering properties of the final building material product. Feedstock is determined by the available local resource base and its technical characteristic has been represented in Table 1.

Table 1

Recommended characteristics of straw feed stock to apply for mycelium-based building composite

Fiber type of straw	Size, mm	Average moisture content, %	Bulk density, g/cm3
Flax	≤ 5	≤ 10	60...80
Hemp	≤ 5	≤ 10	70...90
Wheat	5...10	≤ 10...12	90...110
Rye	5...10	≤ 10...12	150...250
Reeds	5...10	≤ 10...12	260

Conclusion.

1. The analytical review of the mycelium-based materials to apply in construction industry showed the huge potential for implementation in sustainable design directed to minimize the pollution from the sector.

2. Thus, there are a number of researches in the subject there are still gaps in the industrialization process of wide application the studied composites in building industry.

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