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The influence of the binder and volcanic rocks in natural-organic building materials

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Abstract

The building industry needs to implement a new construction system, based on maintaining the balance between the existing natural ecosystems due to its negative impact in the last years on the natural resources. The study started from rethinking the way in which traditional building materials influence the environment and how these can help reduce the pollution of the building sector. Therefore, the research was based on the study of waste raw materials from agricultural sector with different natural binders. The experimental program contains six recipes, in which the main element is hemp hurd, produced in our country. Besides this technical plant, the formulas contain volcanic rocks that help the materials to have a lower density and to improve the fire properties. The natural binders used in the formulas had also an important role for developing the natural-organic materials. On the recipes obtained, three parameters are studied: sound absorption coefficient, thermal conductivity and mechanical resistances. The results were influenced by the composition of the materials. The use of raw waste materials and the multicriterial analysis will concern the products on the list of sustainable building materials, because the purpose of the research is to help the construction industry to reduce its negative impact on the environment.

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Keywords: Natural-organic materials; hemp; natural binder; physical and mechanical properties.

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1. Introduction

The green perspective of new building materials that transform the construction sector in a more sustainable one is the challenge of today.

The eco-friendly materials are needed due to the fact that, at the level of the European Union, the construction industry is responsible for 40% of final energy consumption and 36% of greenhouse gas emissions [1].

The construction industry can decrease the values of the report if it offers alternatives to the synthetic materials on the buildings market. New acoustic and thermal insulation materials based on waste or raw materials with equal performances as the synthetic materials can be the solution for a more sustainable building sector.

According to Eurostat data, from 2012, Romania is the second country after Malta, with the highest percentage of noise and the sixth one regarding the pollution level from the European Union [2].

Romania requires more investments in innovation because this is the way in which it will be able to reduce the negative impact on human life and environment.

A review of the researches made until today, present the fact that agricultural plants can be the future for new eco-friendly materials. Different studies, table 1, present the characteristics of raw materials obtained from the agricultural plants.

Table 1. Agricultural plants properties [3-7].

Agricultural plants	Density kg/m^3	Thermal conductivity W/mk	Sound absorption coefficient α_{max}	Tensile Strength N/mm^2	References
Rice	154-168	0.046-0.566	-	-	[3],[4]
Sunflower (Pitch)	36-152	0.039-0.050	0.82	-	[3],[4],[6]
Straw bale	50-150	0.038-0.067	0.97	-	[3],[4],[6]
Jute fiber	35-100	0038-0.055	-	393-773	[3],[7]
Flax	20-100	0.038-0.075	0.99	345-1035	[3],[6],[7]
Hemp fiber / shiv	20-90	0.038-0.060	0.70-0.95	692	[3],[5], [6],[7]
Corn cob	171– 334	0.101	-	-	[4]
Sansevieria fiber	1410	0.132	-	-	[4]

Hemp is one of the most used agricultural plants in the construction field, with a high potential for ecological construction due to its insulation properties. Hemp-based materials are considered sustainable materials with a positive impact on the environment.

The production, transportation and use of hemp are processes that don't require high energy consumption or CO_2 emissions. The hemp plant has the same rhythm of growth as all plants, by photosynthesis, and the same absorption of carbon dioxide in the environment. By retaining CO_2, hemp eliminates oxygen. The amount of carbon present in hemp straw represents 50% of the total weight of the plant and corresponds to the retention of 1.83 tons of CO_2 per ton of hemp straw [9].

The most well-known hemp based materials from construction industry is the hemp-concrete (hempcrete). The composition of the hemp-concrete is based on hemp shiv-hydraulic lime. Shiv is the wood part of the hemp, which has a similar chemical composition as the wood, but with a lower density. The hempcrete has a non-structural role, so it is used in walls and roofs [8].

New solutions for building materials are studied and a lot of them are composed of the hemp plant. The use of hemp in more and more areas, classifies it as a valuable plant and an important organic resource for the green economy due to its properties, its positive impact on the environment and the high percentage of fiber it contains [10].

According to the data presented by the European Industrial Hemp Association (EIHA), the situation of industrial hemp cultivation has been continuously increasing in the last years, recording 33000 ha in 2016 [11].

In the scientific literature there are only a few studies related to building materials based on hemp-cement and hemp-gypsum. Therefore the present paper aims to provide an investigation on new hemp based materials in composition with cement and gypsum, but also with volcanic rocks.