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Recycling of plastic waste materials in the composition of ecological mortars

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Abstract

Today, the wish to maintain and improve living conditions worldwide has led to a particular focus on ecology issues in all areas of activity, including construction. The research demonstrates that it is possible to solve major problems in the management of plastic waste materials by recycling, and to obtain new building materials. In this study, the optimal recipes for the manufacture of ecological mortars by PVC waste recycling were established. Mortars containing PVC waste have the advantage that their production is less polluting, as it does not involve high energy consumption. The study presented in this paper is finalized with the development of new building materials.

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1. Introduction

Today, the wish to maintain and improve living conditions worldwide has led to a particular focus on ecology issues in all areas of activity, including construction.

The task of the entire construction industry is to contribute to the development of ecological buildings by applying technical and design solutions that facilitate energy saving, and by using local materials with reduced

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embodied energy, low cost and good appearance having minimum environmental impact that ensure the comfort required by users and at the same time, a profitable return for the project initiators [1].

The quality of the indoor environment is a determining factor for health, given that people spend most of their lives inside buildings [2, 3]. In this context, ecological building materials have an important contribution to the achievement of the mentioned objectives.

The manufacture of ecological building materials should not only contribute to a better management of material and energy resources and to a minimization of waste, but also to the obtaining of materials with adequate physical-mechanical properties [4, 5].

Waste from construction and demolition provides a substantial source of raw materials for building works by using construction site waste such as wood, plastic, cardboard, metal, wires, etc.

Synthetic materials, generically termed plastics, are widely used in construction due to their durability and low weight. The low biodegradability of these materials and the presence in large quantities of waste plastic negatively impact the environment [6]. Polyethylene and polypropylene are common thermoplastic materials, which have the advantage of being easy to recycle.

Polyvinyl chloride (PVC) is one of the oldest and most important plastics, being used for the manufacture of pipes, gutters, floors, electric wire insulators, windows, doors, blinds, etc.

PVC waste results at the end of the life cycle of the many products made of this material. Large PVC waste amounts are taken over by recycling companies, which collect, grind, wash them, and in this form waste materials are reintroduced into the technological cycle for the manufacture of new products such as packages, floor covering materials, panels, tiles, slabs, etc.

PVC can contribute by recycling to the obtaining of a wide range of products used in construction, such as materials for the exterior protection of buildings, sheet pile walls, orifice closing elements for windows or tiles, etc.

Several works have been performed to evaluate the possibility of using various types of plastic waste as aggregate in the composition of mortars or concretes [7, 8, 9].

The aim of this study is to find a modality to recycle plastic waste for the manufacture of efficient ecological building materials.

The research problem is the elaboration of a recipe for a new ecological mortar, with minimal embodied energy, with good thermal insulation properties, while ensuring plastic waste recycling and reduced raw material consumption.

2. Material and Methods

Plastic reuse in the building materials industry is an efficient solution, with beneficial effects for the construction industry as well as environmental protection and improvement, at the same time protecting natural resources.

In this context, in what follows we present a synthesis of the theoretical and experimental results of the Building Materials team of the Faculty of Civil Engineering in Cluj-Napoca in the field of plastic waste (PVC) use with the aim to obtain ecological materials.

For the study regarding the effects of PVC waste in the composition of mortar, specimens according to the recipes presented in Table 1 were made.

Table 1. Mortar recipes.

Recipe	Cement [kg]	Lime [kg]	Water [l]	Sand (0-4) [kg]	PVC waste [kg]
I – standard mortar	1.0	0.6	0.75	4.5	0.00
II – 25% PVC waste	1.0	0.6	0.83	3.37	1.13
III – 50% PVC waste	1.0	0.6	0.77	2.25	2.25
IV – 100% PVC waste	1.0	0.6	0.75	0.00	4.5

The materials used for the experimental part were: “Structo Plus” cement, type: CEM II/B-A1(S-LL) 42.5N, produced by Holcim Romania; hydrated lime; sand with 0-4 mm granularity; minced plastic waste (PVC) and water.

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