ETAPA III/2022

Optimizing the experimental models and verifying their functionality. Technology of laboratory for obtaining innovative construction materials embedded with bacterial bioproduct

Phase III/2022 included the following activities: A.3.1. Elaboration and testing of innovative construction materials incorporating bacterial bioproduct, bacterial cells formulated with agro-industrial by-products; A.3.2. Optimizing the composition of construction materials incorporating bacterial bioproduct, bacterial cells formulated with agro-industrial by-products, and demonstrating their functionality; A.3.3. Development and validation of laboratory technology for obtaining innovative construction materials incorporating bacterial bioproduct, bacterial cells formulated with agro-industrial by-products; A.3.4. Dissemination of project results.

Estimated verifiable results of the activities for Phase III/2022 assumed by the Implementation Plan were fulfilled as follows: Functional model – innovative construction materials that include bacterial bioproduct (bacterial cells formulated with agro-industrial by-products); 1 laboratory technology for obtaining innovative construction materials incorporating bacterial bioproduct; 1 patent application; 1 peer-reviewed article sent for publication; 1 published article; participation in national and international conferences; upgrade web site project.

Hence, it was tested a new experimental protocol for obtaining the spore suspension from *Bacillus subtilis* and embedding it in the mortar, to ensure the stimulation of spore germination and implicitly the increase of viability in the mortar matrix (subject to patent application). Experiments were carried out on the inclusion in the mortar mixture of spore suspensions with different optical densities DO600nm, namely, 1.834 (B1), 2.07 (B2), 1.467 (B3), and 1.04 (B4). The spore suspensions were embedded in the mortar mixture and mortar prisms were built which were finally immersed in urea and calcium chloride solution. The mortar samples were cured in these solutions and at predetermined time intervals of 2, 7, 28, and 56 days they were fragmented and analyzed by scanning electron microscopy (SEM) and infrared spectroscopy (FTIR). To verify the viability of bacterial spores in the mortar, fragments of mortar were deposited on solid and liquid nutrient mediums and optical microscopy observations showed that the bacterial spores preserved their viability in the mortar. The mortars were also analyzed through water absorption and compression resistance tests. The presence of bacterial cells in the composition of the mortars led to an increase in their apparent density, compared to the standard mortar, for all storage terms. The water absorption of the mortars with or without bacterial cells decreases with the extended hardening time up to 56 days, and looking at the comparison, it was observed that the values recorded for the samples are lower than the mortars without sporal suspension. It was noted the decrease in the porosity values and implicitly the increase in the compactness of the mortars with bacteria compared to the standard mortar. The presence of bacteria in the mortar, through the microbially induced precipitation of calcium carbonate in the pores, leads to an increase in their durability.

Based on these results, the laboratory technology for obtaining innovative construction materials incorporating bacterial bioproducts, and bacterial cells formulated with agro-industrial by-products was developed and validated. The technology ensures the improvement of some properties of the mortars, namely: apparent density, absorption capacity, compactness, porosity (apparent and total), mechanical resistance, and degree of homogeneity (ultrasonic impulse speed). It is considered that exploiting the biomineralization process through various practical applications represents an environmentally friendly way with significant implications in reducing energy consumption.

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