



STONE COMPOSITES MADE WITH WASTE FROM THE CARBONATE ORNAMENTAL STONE EXTRACTION AND PROCESSING INDUSTRY

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Summary: *Application of carbonate sludge and marble aggregates in the production of stone composites with incorporated polyester resin.*

Key words: *composites, marble, limestone, waste, polyester*

The carbonate sludge resulting from the Portuguese industrial processing of marble and/or limestone exploited in the Estremoz Anticlinal and the Estremadura Limestone Massif, respectively, where studied in this work.

As these are homogeneous and relatively pure materials (> 95% CaCO₃), after drying they turn into an extremely fine powder with a high potential for industrial application, which justifies studying the technical and economic feasibility of applying them to new products, adding economic value and contributing to their classification as a by-product. This carbonate powder has a good bonding capacity with aggregates, allowing it to be used as a raw material in mortars and the production of more sustainable stone composites.

The research reported was carried out at the Geosciences Department of the University of Évora as part of the Calcinata project (Co-promoted Companies R&TD Project, reference no. 72239, co-financed by Alentejo 2020, Portugal 2020 and the European Union through the 'European Regional Development Fund' Programme). The project partners were Ineditbrown Lda (leader) and Solid Defender, Máquinas Industriais Lda. The project was managed by the Portugal Mineral Resources Cluster Association and the University of Évora's Project Support Office (Martins et al., 2021, 2022, 2022a; Afonso et al., 2023a, 2023b, 2024).

Despite the widespread use of epoxy resins in the stone industry, studies have focused on the application of polyester resin for technical and economic reasons.

Since carbonate powders are a waste product of the extraction and processing industry in the natural stone sector (also called 'ornamental stone' or even 'dimension stone' in Anglo-Saxon nomenclature), proving their industrial application adds economic value to them, thus making it possible to replace the current classification as waste with the classification of by-product (Alves, 2015; Juvandes, 2002; Korneliussen et al., 2014; Ventura et al., 2009).

The research followed a previously planned timetable, which considered the diversity of the powders resulting from the drying of marble and limestone sludge. Sampling took place in the Marble Zone, with samples of marble carbonate sludge being taken from the companies António Galego & Filhos - Mármore SA, referred to as M(AGF) and A.L.A. de Almeida SA., referred to as M(A), and in the Estremadura Limestone Massif (Santarém) with the collection of limestone carbonate sludge samples from the companies Solancis - Sociedade Exploradora de Pedreiras SA, referred to as C(S), and MVC - Mármore de Alcobaça Lda, referred to as C(MVC). The aggregates used were produced by crushing marble blocks at Marvisa, Mármore Alentejanos Lda. The aggregates used correspond to three granulometric fractions, commercially known as "Bago de Arroz" (BA), "Brita 1" (B1) and "Brita 2" (B2).

The carbonate powders were characterized physically and chemically, determining particle size distributions, volume masses, chemical compositions and mineralogical compositions.

The compositions with the best performance in the different mechanical tests carried out were the

formulations with the proportions 52% Aggregate (40%BA/40%B1/20%B2) / 48% Binder (52%NM / 48%R2). NM corresponds to marble powder and R2 to the reference polyester resin Recapol 2196.

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