



PERFORMANCE OF CARBONATED SLUDGE-BASED COMPOSITES (MARBLE AND LIMESTONE): UNIAXIAL COMPRESSIVE AND FLEXURAL STRENGTH UNDER CENTRAL LOADING AFTER FREEZE-THAW CYCLES AND THERMAL SHOCK

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Summary: The Calcinata Project - Production of lime-based mortars from carbonate sludge from the ornamental stone industry (marble and limestone), completed in 2023, investigated an alternative for the utilisation and recovery of waste (carbonate sludge) from the extraction and processing of ornamental stone. Sludge recycling has significant potential. Its use as a raw material in the integration of the production of polyester resin binders, commonly used in the manufacture of natural stone composites, can partially or totally replace the use of epoxy resins traditionally used in these products.

This research shows the behaviour of these new composites in uniaxial compressive strength (EN 1926) and flexural strength tests under central loading (EN 12372) tests before and after 56 freeze-thaw cycles (EN 12371) and thermal shock ageing (Table 1). In compressive strength tests, the composites showed reductions of 11% and 26% for marble and limestone sludge, respectively, after freeze-thawing. Thermal shock resulted in more significant decreases: 28% for marble and 36% for limestone, possibly associated with thermal degradation of the resin. In the flexural strength tests, the limestone sludge composites showed a 24% reduction after freeze-thawing, while the marble composites showed no significant changes. After thermal shock, the reductions in flexural strength were 41% for marble and 43% for limestone. The results confirm the potential of carbonate sludge as a raw material in the production of sustainable

composites, in line with the “Circular Economy Action Plan” and promoting greater sustainability in the sector (Afonso *et al.*, 2024; 2023a; 2023b).

Table 1. Results of the uniaxial compressive strength and flexural strength tests before and after 56 freeze-thaw and thermal shock ageing cycles.

Tests	Binder	R (MPa)	After freeze-thaw	After thermal shock
Compression Strength	Marble	88,19	78,29	63,36
	Limestone	91,96	67,83	59,04
Flexural strength	Marble	15,49	15,70	9,09
	Limestone	13,49	10,25	7,69

Key words: Carbonated Sludges, Ornamental Stone Composites, Freeze-Thaw Resistance, Thermal Shock Ageing, Circular Economy

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