Enhancing Soil–Cement Properties Using Glass Polishing Waste: Impact of Porosity and Binder Indices

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Abstract

This study explores the potential of glass polishing waste (GPW) in improving clayey soil from the Guabirotuba formation. The research stands out by developing a novel geomaterial

and proposing equations to predict mechanical behavior, focusing on the effects of porosity (η), GPW content, and cement on unconfined compressive strength (q_u), splitting tensile strength (q_t), and durability through accumulated loss of mass (ALM). This research contributes to understanding the parameters that influence the mechanical strength and durability of soil–cement, and soil–cement-GPW blends through the adequacy of the porosity/cement content (η/C_{iv}) and porosity/binder content (η/B_{iv}) indices on q_u, q_t, and ALM. Soil–cement-GPW blends and a control group (soil–cement) were analyzed, and the microstructure of the best blends was evaluated using scanning electron microscopy (SEM). The results showed that the soil–cement-GPW blends exhibited superior mechanical strengths compared to the soil–cement blends, reaching a maximum value of q_u = 3176 kPa and q_t = 946 kPa after 90 days in the soil + 8%cement + 15%GPW blends compacted at the modified effort. Soil–cement specimens showed higher ALM (soil + 8%cement; ALM = 8.1%) than the blends with GPW (soil + 8%cement + 15%GPW; ALM = 2.5%). The q_u of specimens in durability tests decreased by 15% to 49.5% compared to those in q_u tests after 28 days of curing, with the highest losses in blends with lower cement content and no GPW. The results of q_u, q_t, and ALM were successfully correlated with the η/C_{iv} and η/B_{iv} indices in power-type relationships. These indices proved effective for predicting q_u, q_t, and ALM, replacing conventional trial-and-error strategies that are typically labor-intensive and time-consuming.

Data Availability

Data will be made available on request.

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Ethics declarations

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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