Research and Technical Analysis of Marine Waste PET Fiber Spray Concrete for Coastal Slope Protection

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Abstract:

The resource utilization of marine plastic waste and the improvement of the durability of coastal slope protection materials are urgent issues that need to be addressed in sustainable civil engineering. Mudstone formations are widely distributed in southwestern Taiwan and coastal areas. Due to the influence of rainfall infiltration, dry-wet cycles, and salt-hazardous environments, slopes are prone to weathering, loosening, crack development, and local collapse. Although the traditional shotcrete method offers fast construction and good slope coverage, steel fiber or steel reinforcement systems may corrode and deteriorate in high-chloride environments, thereby compromising the long-term stability of the protective layer. Recycled polyethylene terephthalate (PET) fibers have the characteristics of light weight, good corrosion resistance, and ductility. If they can be introduced into shotcrete systems, it will help to meet the needs of marine waste reuse, crack control, and coastal slope protection.

In response to the issues of ball formation, uneven dispersion, decreased workability, and rebound loss that may occur during the mixing and spraying process of PET fibers with a high aspect ratio of approximately 25 mm in length, this article proposes improvement strategies based on material design and technical analysis, including fine aggregate gradation reorganization and a full material dry mixing process. The fine-bone material system can be optimized through tight packing to enhance slurry-coating performance and material cohesion. Fibers can be dry-mixed with cement and fine bone materials to achieve initial dispersion before adding water, thereby reducing the risk of local aggregation of long fibers. The subsequent evaluation framework may include fluidity tests, simulated spray rebound rate evaluations, compressive strength tests, and observations of post-fracture failure modes and fiber-bridging behavior. Based on existing literature and technical analysis, it can be concluded that the improvement in peak compressive strength by PET fibers may be limited, and their engineering value should focus more on crack bridging, residual bearing capacity, and improved integrity after failure. This material design architecture can serve as a reference for the subsequent development of low-rebound, high-toughness, and corrosion-resistant recycled PET fiber shotcrete and provide a material design direction that combines sustainability and engineering applicability for coastal mudstone slope protection projects.

Keywords:

Sustainability, recycling and reuse, mortar, marine waste fiber, coastal landslide-prone slopes.