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Particle Size Dependent Enhancement of Compressive Strength and Carbonation Efficiency in Steel Slag Cementitious Composites

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Abstract : The utilization of industrial by-products, such as steel slag in cementitious materials, not only mitigates environmental impact but also enhances material properties. This study investigates the dual influence of steel slag particle size on the compressive strength and carbonation efficiency of cementitious composites. Through a systematic experimental approach, steel slag particles were incorporated into cement at varying sizes, and the resulting composites were subjected to mechanical and carbonation tests. Scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX) are conducted in this paper. The findings reveal a positive correlation between increased particle size and compressive strength, attributed to the improved interfacial transition zone and packing density. Conversely, smaller particle sizes exhibited enhanced carbonation efficiency, likely due to the increased surface area facilitating the carbonation reaction. The presence of higher silica and calcium content in finer particles was confirmed by EDX, which contributed to the accelerated carbonation process. This study underscores the importance of particle size optimization in designing sustainable cementitious materials with balanced mechanical performance and carbon sequestration potential. The insights gained from the advanced analytical techniques offer a comprehensive understanding of the mechanisms at play, paving the way for the strategic use of steel slag in eco-friendly construction practices.

Keywords : steel slag, carbonation efficiency, particle size enhancement, compressive strength
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