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Strength Properties of Concrete with Ground Granulated Blast Furnace Slag (GGBS) as Partial Cement Replacement : A Review

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Abstract: *The construction sector is under increasing pressure to reduce the environmental burden of Portland cement production, which significantly contributes to global greenhouse gas emissions. Ground Granulated Blast Furnace Slag (GGBS), a supplementary cementitious material derived from industrial by-products, has emerged as a viable solution for enhancing the sustainability of concrete. This literature review synthesizes two decades of research (2004–2024) on the effects of GGBS incorporation in concrete and related cementitious composites. Studies consistently report that partial replacement of cement with GGBS (typically 20–40%) improves long-term compressive strength, durability, and resistance to chloride ingress, while also reducing permeability and enhancing microstructural densification. Early-age strength reduction is a common limitation, especially at higher replacement levels, though this can be mitigated with curing optimization, mineral admixtures, or fiber reinforcement. Investigations further reveal that higher GGBS contents (50–80%) can be applied effectively in specific cases, particularly when durability and sustainability are prioritized over rapid strength gain. Recent advancements highlight the synergy of GGBS with silica fume, copper slag, crusher dust, and fibers, producing concretes with improved mechanical performance, durability, and reduced environmental impact. Overall, the review establishes GGBS as a versatile supplementary cementitious material that not only reduces cement consumption and CO_2 emissions but also enhances long-term performance, supporting its use in eco-friendly and durable concrete structures.*

Keywords: Cement, GGBS, Replacement ratio (0–20%), Partial cement replacement, Industrial by-products utilization

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