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REVIEW PAPER

Bibliometric Analysis of High-Strength Self-Compacting Concrete Performance Containing Silica Fume and Fly Ash: Review

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Abstract

A global projection suggests that cement production contributes 5% to 8% of carbon dioxide emissions and, at the same time, has heavy raw material turnover, affecting the environment. Therefore, there is a considerable amount of research globally on implementing industrial waste by-products in concrete production instead of cement. Two industrial by-products, silica fume (SF) and fly ash (FA), can be used as partial replacements for cement in high-strength concrete. On the other hand, the literature review has revealed unconfirmed tendencies on the impact of using SF and FA as supplementary cementitious materials as partial cement replacement on high-strength concrete's physical, mechanical, and durability characteristics. This review is intended to assess the possibility and the possible benefits of employing SF and FA as SCMs and assess them as a partial cement replacement in the production of regular concrete. Using these SCMs, the paper investigates how the following cementing properties affect SMCs' morphology, mechanical performance, and durability of concrete. SF and FA impacts are primarily due to pozzolanic activity and filler properties. Furthermore, the obtained results reveal that SF's high surface area and relatively amorphous structure give it the highest reactivity and a faster pozzolanic reaction than FA, which has moderate reactivity because of its crystalline nature. Research indicates that it is possible to include an FA and SF up to approximately 20%: porosity and permeability decrease, and at the same time, compressive strength and durability increase because of the filler action of SF. For the case of concretes containing FA and SF, the obtained permeability and compressive strength ranges were 0.17–1.46 cm/s and 4–35 Mpa, and 0.56–2.28 cm/s and 3.1–35 Mpa. It has a silica content of 28 cm/s, 3000 kg/m^3, and 0.7 MPa, respectively, and it is helpful for non-structural-concrete applications. Therefore, incorporating up to 20% of FA and SF in concrete production is an effective way of developing sustainable concrete that will help minimize the use of cement, carbon footprint, energy, and Air pollution from the conventional cement production method. The review determines some factors that reduce the marketability of sustainable concrete made from industrial waste byproducts. The first step in this research is a bibliometric analysis of 598 research articles, and the second step is a profound analysis of silica fume and fly ash as two primary materials. It identifies challenges for moving sustainable concrete into the market and provides insights to authors and industry players interested in realizing market-ready SC solutions, especially in high-strength concrete.

Keywords Supplementary cementitious materials · Mechanical properties · High strength · Self-compacting · Durability · Silica fume · Fly ash

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