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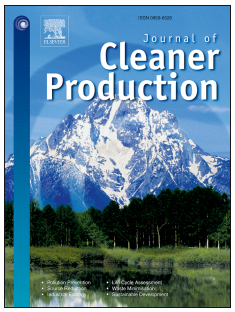

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Utilization of high-volume treated palm oil fuel ash to produce sustainable self-compacting concrete

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Abstract

Palm oil fuel ash is an supplementary cementitious material (SCM) generated from the combustion of palm oil fibers and shells in palm oil mills to produce electricity, and One approach to reduce the carbon dioxide emissions and increase the sustainability of concrete by substitute a significant amount of ordinary Portland cement (OPC) with it. This study conducted laboratory investigations to evaluate the use of high-volume treated palm oil fuel ash (T-POFA) in producing economical and eco-friendly self-compacting concrete (SCC). The concrete mixtures were prepared with 0%, 50%, 60% and 70% replacement (by mass) of OPC with T-POFA at a constant water/binder ratio of 0.35. Self-compactability testing methods were also employed to evaluate the fresh properties of SCC. Compressive strength and drying shrinkage tests were performed and investigated for up to 6 months and 1 year, respectively. An acid attack resistance test was also conducted on the concrete specimens. Results show that the substitution of OPC with high-volume T-POFA can improve the fresh properties of concrete. At an early age, SCCs containing 50%–70% T-POFA have lower compressive strength than the control SCC mix containing 100% OPC. However, the concrete specimens attained a compressive strength equivalent to that of the control at an age of 28 days and an even higher compressive strength at later ages. The specimens containing high-volume T-POFA have lower drying shrinkage and exhibited better performance against aggressive chemical attack. Cost analysis and carbon dioxide (CO_2) emission calculation showed that the T-POFA concrete specimens have 8%–12% lower cost and up to 45% lower CO_2 emission than the control SCC mix. The results suggest that T-POFA can be utilized as a cement replacement up to 70% in SCC to produce low-cost and sustainable concrete.

Abbreviations: POFA, Palm oil fuel ash; G-POFA, Ground palm oil fuel ash; T-POFA, Treated palm oil fuel ash; SF, Slump flow; JF, J-ring flow; f_{CR}, Reduction in compressive strength reduction**;** ML, Mass loss; T_v, V-funnel flow time; T_{50cm}, T_{50cm} flow time.

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