Editorial

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From landfill to sustainable concrete

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Editorial

Due to the recent advancement and development worldwide, the rate of producing solid industrial by–products has increased significantly. Several studies are being conducted to investigate the impact of industrial by–products on the environment and on studying potential applications for recycling and reusing such industrial by–products. Concrete is the most used construction material worldwide, and several billions of cubic meters are produced annually, the use of industrial by–products in concrete– attracted many investigators. Concrete has been looked at as a scavenger of several industrial solid waste materials such as ground granulated blast furnace slag, fly ash and silica fume, and it can take the lead to reuse other industrial solid waste materials. Ceramic waste powders (CWP), ladle slag (LS), red mud (RM) and sewage sludge ash (SSA) are examples of such industrial solid wastes. Most of these by–products end up in stockpiles and landfills causing serious environmental threat. The generation of these by–products cannot be eliminated. However, its environmental impact can be mitigated by creating more sustainable use of these by–products. CWP was investigated as partial replacement of cement in conventional vibrated concrete mixtures. CWP was used to replace cement up to 40% by mass. Replacing cement with CWP up to 20% resulted in a slight decrease in strength but significantly improved the durability characteristics of the produced concrete. Strength increased at late ages indicating CWP pozzolanic reactivity. Higher replacement levels resulted in significant reduction in strength but superior durability performance. The microstructure of the CWP concrete showed similar characteristics to those using conventional supplementary cementing materials (SCM) such as fly ash and silica fume.

RM was used as a partial cement replacement in a conventional vibrated mortar and concrete mixtures, and it showed pozzolanic activity. RM replaced cement up to 50%. However, RM was reported to decrease the workability of the mixtures. The use of RM with high replacement levels above 20% reduced the hydration heat and consequently the achieved strength. Conversely, the use of 20% to 30% RM as partial cement replacement improved the mixtures' resistance to chloride ion diffusion, increased the electrical resistivity and lowered the corrosion rate. The microstructure of cement paste including RM as cement replacement revealed the presence of hydration products similar to that of pure cement past. LS was used as partial cement replacement up to 60%. LS was characterized with some hydraulic reactivity as well as some pozzolanic reactivity. High percentages of LS significantly reduced compressive strength while moderate levels (i.e., 15% to 20%) exhibited good mechanical strength. Higher strength gain was observed at late ages. Mixtures including LS up to 30% showed similar or improved porosity and durability performance compared to mixtures without LS. Concrete including LS showed no difference in microstructure compared to conventional ones without LS. SSA is characterized by its chemical composition that indicated latent hydraulic and latent pozzolanic characteristics which suggest that SAA has the potential for being used as an ingredient in concrete. Also, the high alumina content of SSA could be beneficial in concrete mixtures to improve its resistance to chloride attack, due to the binding of chlorides by the alumina. The sintering temperature and time showed a significant effect on the SSA characteristics.

High–temperature sintering of sewage sludge is needed to increase the glassy phase in the produced SSA. SSA was used to replace cement up to 20%. The inclusion of SSA showed contradicting results on the compressive strength of the produced concrete. The effect of SSA on the produced concrete was found to be affected by several factors such as particles' size, curing condition, and mixture proportions. The main conclusion of all studies indicated that industrial solid waste materials (i.e., CWP–RM–LS–SSA) could be used in replacement of cement to produce cementitious composites suitable for various civil applications. Although the use of industrial solid waste materials has attracted several researchers, yet recent studies pointed out that there still research gaps that need to be investigated. Recent studies indicated the need to thoroughly investigate the effect of different solid waste materials on cement hydration, the relation between pore structure and mechanical properties, and the durability and volume stability due to drying shrinkage of concrete. Also, the combination of solid waste materials in binary or ternary blends with other SCM for partial cement replacement in concrete needs investigation.

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Conflict of interest

The authors declare there is no conflict of interest.

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