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Valorization of bone-china ceramic powder waste along with granite waste in self-compacting concrete

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Highlights

- BCPW and GW were used as cement and fine aggregate replacement, respectively.
- Most of the resulting SCC mixtures satisfy the SCC criteria.
- Pozzolanic behaviour of BCPW and better filler efficacy of GW particles led to improve compressive strength and resistance to carbonation.
- Dense microstructure of $C_{10}G_{30}$ mix was observed through SEM and MIP analysis.

Abstract

This study examines the feasibility of bone-china ceramic powder waste (BCPW) and granite waste (GW) as a cement and fine aggregate (river sand) in the production of self-compacting concrete (SCC), respectively. BCPW added in 0%, 10%, 20% and 30%, and GW used in 0%, 20%, 30% and 40% to produce the concrete mixes. Total of sixteen mixes was cast including control mix, three mixes each for BCPW and GW, and nine mixes for combined use of BCPW and GW. Fresh, mechanical, and microstructure tests were performed to evaluate the performance of SCC made with BCPW and GW. The positive influence on fresh properties was recorded with BCPW and GW, and most of the values were found in an acceptable range as per the EFNARC standard. SCC mix prepared with combined utilization of 10% BCPW and 30% GW (i.e. $C_{10}G_{30}$ mix) showed maximum strength. Higher apparent density, lesser permeable voids and increased carbonation resistance were observed with the optimum use of BCPW and GW in SCC. Dense microstructure was seen from scanning electron microscopy (SEM) images for $C_{10}G_{30}$ mix. Also, larger number with higher intensity peaks of CSH gel were observed for $C_{10}G_{30}$ mix from X-ray diffraction (XRD) analysis. Mercury intrusion porosimetry (MIP) analysis also displayed a minimum porosity for $C_{10}G_{30}$ mix. The improved performance of SCC was mainly because of pozzolanic behaviour and finer particle size of BCPW, and better filling property of GW. The results suggested the optimum utilization of BCPW up to 10% and GW up to 30% as a cement and fine aggregate replacement in SCC, respectively, which not only helps in cost reduction but also offers sustainability.

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