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Hydrochloric acid based pre-treatment on paper mill sludge ash as an alternative source material for geopolymer

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Abstract

This study focuses on the pre-treatment of paper mill sludge ash (PMSA) as a by-product of paper milling industry that contains high amount of calcium, yet low in silica. The presence of high calcium content in geopolymer system will accelerate the setting time of fresh geopolymer and may disrupt the development of its mechanical strength. Therefore, in this study, the refinement of PMSA properties was conducted by treating raw PMSA in hydrochloric acid solution with different molarities of 0.5 M, 1.0 M and 1.5 M. The pre-treatment process was mainly purposed to decrease the amount of calcium and other impurities through leaching mechanism. Characterization of raw materials and pre-treated PMSA was done based on ICPMS and XRF analysis for its leachate and oxide analysis, respectively, while the effect of pre-treated PMSA on geopolymer properties was conducted by adding the pre-treated ash as a replacement material for fly ash at various percentages of replacement (5%, 10%, and 15%). Based on the experimental results, 1.5 M hydrochloric acid solution (HCl) was determined as the optimum concentration due to its ability in removing higher amount of calcium from the ash, yet still able to increase the amount of silica. Testing on the hardened properties of geopolymer specimen also showed the deceleration of fresh fly ash based geopolymer and produced a more workable fresh geopolymer. Higher workability has led to a denser and more compact specimen, which contributed to the higher mechanical strength of hardened specimen, particularly in 5% pre-treated PMSA specimen. Therefore, the use of PMSA as an alternative source material for fly ash based geopolymer has presented a favourable potency, particularly after the pre-treatment process with HCl.

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