UNIVERSITI TEKNOLOGI MARA

INFLUENCE OF PRESOAKING TREATMENT WITH HIGH MOLARITY HYDROCHLORIC ACID ON THE CHARACTERISTICS OF CRUSHED CONCRETE WASTE AGGREGATE HIGH PERFORMANCE CONCRETE

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

Crushed Concrete Waste Aggregate (CCWA) primarily differs from the natural aggregate by the remainder of hardened mortar adhered onto the surface of the natural aggregate (NA). Pre-soaking CCWA in hydrochloric acid (HCl) solution is an effective technique for the removal of old, adhered mortar. However, since High Performance Concrete (HPC) was the target, the use of pre-soaked CCWA in HCl with a molarity range between 0.1 M to 0.5 M had presented significantly inferior results compared to NA. Thus, further research must be conducted on the pre-soaking of CCWA in HCl with higher molarities to remove the old, adhered mortar. Its influence on the properties of the resulting HPC should be assessed. The treatment of CCWAs with HCl addressed the impact of HCl's molarity on CCWA properties as well as HPC production. The properties of the resultant HPC were analysed and evaluated using three types of CCWA, designated as: untreated CCWA (CCWA0.0H), treated CCWA with HCl of 0.5M (CCWA0.5H) and treated CCWA with HCl of 12.8M (CCWA12.8H). A comparison was subsequently made with NA HPC. The methodology of this research was divided into two parts. The first part determined the optimal HCl molarity for removing the adhered mortar. The second part evaluated the influence of treated CCWA on the properties of HPC in comparison to both HPC with untreated CCWA and NA. Fifteen specimens with varied contents of CCWA treated with different molarities of HCl were prepared. The aggregate crush value, aggregate impact value and water absorption as well as a correlation between the treatment variables (such as the size of the aggregate, time of submersion in HCl, CCWA microstructure and HCl molarity) were analysed to determine the optimal molarity of HCl. The features of HPC such as workability, compressive strength, tensile strength, water permeability, drying shrinkage as well as the microstructure and failure patterns were investigated to examine the influence of CCWA on the characteristics of HPC. The experimental results were analysed using the Statistics software (SPSS). The findings revealed a significant correlation between the HCl molarity and CCWA properties. Higher HCl molarity produced better quality CCWA. The 12.8 molarity (M) offered an optimum treatment result. The HPC with CCWA12.8H presented a similar behaviour to HPC with NA; whereas the HPC with CCWA0.5H and CCWA0.0H displayed an inferior behaviour compared to NA HPC. The flowability of HPC exhibited a significant reduction when both CCWA0.5H and CCWA0.0H had replaced NA. However, when CCWA12.8H replaced NA, the flowability test outcomes were similar to the specimens made of NA. The compressive and tensile strengths of HPC made of CCWA12.8H were similar to those of HPC made of NA. However, when both CCWA0.5H and CCWA0.0H were utilised as 100% replacements of NA, the HPC had presented a 30% reduction in compressive strength and a 40% reduction in tensile strength. The water permeability recorded a comparable value among all mixes prepared with CCWA12.8H as the mixes with NA. However, the water permeability tended to increase when either CCWA0.0H or CCWA0.5H was used in HPC. A 70% rise in drying shrinkage among all water cement ratios was reported when CCWA0.0H and CCWA0.5H were employed. However, HPC specimens prepared with CCWA12.8H had recorded identical drying shrinkage values with a marginal difference of less than 5%, similar to the specimens prepared with NA. The treatment process with HCl demonstrated significant success with only 12.8M. This finding confirmed the microstructure analyses of both CCWA and HPC containing CCWA, whereby the NA HPC and CCWA12.8H recorded similar failure patterns.

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