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Structural Properties of Concrete Containing Ground Waste Clay Brick Powder as Partial Substitute for Cement

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Abstract. With the increasing concerns on the impact of cement production on the environment and the need to protect the environment, the use of mineral additives as cementitious material to partially substitute cement is being considered as an effective option. One of such material is fired clay brick which can be sourced as generated waste from clay brick industry. This has an added advantage of reducing industrial waste and preserving the natural resources. The experimental objective of this study is to examine the possibility of utilizing clay brick waste as partial replacement for Portland cement in concrete. The clay brick was finely ground into powder size, and after grinding, the morphological characterization of the powder materials was carried out using scanning electron microscopy (SEM). Moreover, the chemical composition of the brick material was determined using X-ray fluorescence (XRF). Laboratory tests were carried out to determine the workability, split tensile and compressive strength properties of the concrete with 0%, 10%, 20%, 30% and 40% partial replacement of cement with ground clay brick (CB). From the test results, the chemical composition of the brick powder meets the standard requirements for pozzolanic material, with the SEM revealing an amorphous solid mass. The workability of the concrete reduces with increase in brick powder content. A significant improvement of the split tensile and compressive strength of the concrete was achieved at 10% cement replacement, after which a decrease in strength with increasing ground clay brick content was recorded. The use of ground clay brick of not more than 15% was recommended for concrete production.

Introduction

Focus on new alternative cementitious materials to substitute cement is continually advancing. Some waste materials are being researched on as materials which can be recycled as a partial substitute for cement in concrete production. This helps in providing solutions to the menace of waste and effect of greenhouse gases on the environment. However, to effectively adopt these waste materials as alternative binder or additive materials, it is important that detailed and accurate information on the engineering, mineralogical, morphological, physical and chemical composition properties are known [1]. It was reported by [2] that supplementary cementitious materials (SCM) generated by industrial by-products such as fly ash or blast furnace slag in binder mixes can help achieve an improved concrete properties such as improved mechanical strength and durability of concrete. Moreover, using SCM including natural pozzolans as partial replacement to cement in concrete reduces the impact of cement on the environment [3, 4] and at the same time offer additional benefits in the performance of cement [5] including cost and energy saving [6]. Recently, effort have been made in the concrete industry to investigate the reuse of clay brick waste generated by ceramic brick manufacturing factory as alternative cementitious material to partially substitute cement in mortar and concrete [7, 8].

Studies by [9] stated that clay brick which mostly composed of silica and alumina compounds assume its pozzolanic characteristics when activated by thermal treatment by calcination at temperature not less than 900 °C. This is due to the transformation of the raw clay primary nature