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Structural Characteristics of Reinforced Palm Kernel Shell Concrete Deep Beams

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Abstract

This paper evaluates the structural characteristics of deep beams made from reinforced palm kernel shell concrete (PKSC) and normal weight concrete (NWC). Twelve PKSC and NWC deep beam samples, with and without shear reinforcement were tested under three-point loading and their structural behavior studied. The ultimate shear strength of PKSC beams increased with a decrease in the shear span-to- depth ratio. Post diagonal cracking shear resistance is greater in PKSC deep beams than beams of normal weight concrete. The shear capacity of the PKSC and NWC deep beams were assessed to be un-conservative using ACI 318-99, ACI 318-05, Euro code (EC) 2 and a kinematic model, when compared with the experimental results. Nonetheless, this necessitated the development of a calibration procedure to correct the bias inherent in these models. Calibrated shear strength models revealed the compressive strength and the ratio of the shear span-to-total depth as significant influential parameters for correcting the inherent bias in the original deterministic shear strength models. The calibrated functional model of ACI-318-99 may produce conservative predictions, given this limited number of test specimens. Therefore future studies should investigate the reliability of the calibrated models, and quantifying the uncertainties in the estimated coefficients of parameters, using a much larger representative dataset.

Keywords: Shear; Palm Kernel Shell; Deep Beams; Code Assessment.

1. Introduction

Concrete has a widespread application in the construction industry. The increased demand for concrete as a construction material, has yielded the investigation into unconventional building materials such as steel milled from scrap metals [1–3], bamboo reinforcement in concrete [4–6], phyllite aggregate waste in concrete [7], palm kernel shell aggregate in concrete [8, 9]. Conventionally, rocks of igneous, metamorphic and sedimentary origins such as granite, basalt, flint, limestone etc. [10, 11] have been used to produce coarse aggregates for concrete production over the years. Nonetheless, there has been increased use of coarse aggregates, which serve as economic filler in concrete, for construction purposes. This practice is leading to over-exploitation of natural rock resources in the environment and a depletion of sources of coarse aggregates.

There is therefore the need to find alternative coarse aggregate resources to replace natural ones. Research conducted on various solid waste materials; such as granulated coal ash, blast furnace slag, fiberglass waste materials, granulated plastics, sintered sludge pellets, phyllites from mining waste, ceramic waste and recycled concrete; as coarse aggregate substitutes has proved very successful [7, 12, 13]. Most of these waste materials constitute artificial light weight aggregates [14] and their introduction to replace conventional aggregates for concrete production in some developed

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