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Absorption Characteristics of Lightweight Concrete Containing Densified Polystyrene

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Abstract

The environmental impacts of the construction industry can be minimised through using waste and recycled materials to replace natural resources. Results are presented of an experimental study concerning capillary transport of water in concrete incorporating densified expanded polystyrene (EPS) as a novel aggregate. A new environmentally friendly technique of densifying was used to improve the resistance to segregation of EPS beads in concrete. Twelve concrete mixes with three different water/cement ratios of 0.6, 0.8 and 1.0 with varying novel aggregate content ratios of 0, 30, 60 and 100% as partial replacement for natural aggregate by equivalent volume were prepared and tested. Total absorption, absorption by capillary action, and compressive strength was determined for the various concrete mixes at different curing times. The results indicated that there is an increase in total water absorption (WA) and capillary water absorption (CWA) and a decrease in compressive strength with increasing amounts of the novel aggregate in concrete. However, there is no significant difference between the CWA of control and concretes containing lower replacement level.

Keywords: Capillary Water Absorption; Compressive Strength; Concrete; Environment; Recycling; Waste Expanded Polystyrene.

1. Introduction

The environmental impacts of the construction industry have been a major contributor to the environment pollution all over the world. However, these impacts can be minimized through using waste and recycled materials e.g. waste polystyrene to replace natural resources. Many by-products and solid recyclable materials can be used in concrete mixtures as aggregates or cement replacement, depending on their chemical and physical characterization; thus concrete can become an environmentally sustainable material [1].

According to the literature, capillary water absorption (CWA) of concrete is the phenomenon by which water is absorbed into concrete by capillary action [2, 3]. Generally, to examine the durability of concrete, absorption characteristics including CWA is employed. A recent study [4] investigated the effect of EPS aggregate size on strength and moisture migration characteristics of lightweight concrete containing fly ash as a supplementary cementitious material. The results indicate that for comparable aggregate size and concrete density, concrete with unexpanded polystyrene (UEPS) aggregate exhibited 70% higher compressive strength than EPS aggregate. Moreover, the results indicate that the EPS concrete containing bigger size and higher volumes of EPS beads show higher moisture migration and water absorption.

According to another study [5], due to the lightweight properties of EPS beads and their hydrophobic surface, EPS concrete is prone to segregation during casting, which results in poor workability and lower strength. In their study a "sand-wrapping" technique was used. The research showed that EPS concrete with a density of 800–1800 kg/m^3 and a compressive strength of 10–25 MPa can be made by partially replacing coarse and fine aggregate by EPS beads. Also,

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