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Aerated Concrete Produced Using Locally Available Raw Materials

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Abstract

Aerated concrete materials were developed with abundant natural materials. Aerated concrete can provide insulating qualities complemented with secondary structural attributes when used as core in sandwich composites for building construction. A hybrid binder that comprised lime and gypsum was used. Different foaming agents were considered for production of aerated concrete, including saponin that is found abundantly in different plants. Different formulations were considered, and the stability of the foam structure as well as the density and early-age compressive strength of the resulting aerated concrete were evaluated. One formulation comprising lime-gypsum binder with saponin foaming agent, with a density of 0.53 g/cm^3, was further characterized through performance of thermal conductivity, split tension, flexure, elastic and shear modulus and sorptivity tests. The results pointed at the satisfactory balance of qualities provided by the aerated concrete when compared with alternative aerated concrete materials.

Keywords: Aerated Concrete; Foaming Agent; Lime-Gypsum Binder; Density; Mechanical Properties.

1. Introduction

Aerated concrete comprises an inorganic binder in which a relatively high concentration of air voids that are introduced using a foaming agent to produce distinctly low bulk densities when compared with normal-weight or even structural light-weight concrete materials. The binder composition and the method of curing influence the microstructure and thus the physical and mechanical properties of aerated concrete [1, 2]. Aerated concrete provides a high degree of thermal insulation and savings in the costs of structural support systems, which are due to its low bulk density [2-4]. It can also provide viable structural qualities for use as the core of sandwich composites in building construction. The purpose of this work was to develop aerated concrete materials with low-cost, energy-efficient and abundantly available binder materials and foaming agents. A hybrid lime-gypsum binder was used in this investigation. Past work on sustainable binders (used without aeration) has relied upon biomass ash and natural materials (e.g., laterite soils and pumice) to produce, via simple and energy-efficient processing techniques, hydraulic binders for concrete production [5-7]. A common theme here is to avoid the high processing temperatures of Portland cement, which can be achieved only in industrial settings [8, 9].

Aerated concrete comprises foams that are formed and stabilized in the mixing water of concrete using a surfactant (surface active) foaming agent [10]. Foaming agents stabilize the air bubbles formed in water during (intense) stirring. Foaming agents comprise surfactants with polar (hydrophilic) and non-polar (hydrophobic) ends. The hydrophilic ends of the surfactant molecules cluster in air bubbles, with their hydrophilic ends pointing at water, thereby stabilizing the air bubbles formed in water [11]. In this capacity, the surfactant acts as an emulsifier, which refers to molecules that help normally repulsive ingredients (like water and air) to mix. Considering the breadth of surfactant applications, they are available abundantly across the world.

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