Accepted Manuscript

Original Article/Research

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PII: S2212-6090(16)30122-4
DOI: http://dx.doi.org/10.1016/j.ijsbe.2017.03.002
Reference: IJSBE 162

To appear in: *International Journal of Sustainable Built Environment*

Received Date: 24 July 2016
Revised Date: 16 March 2017
Accepted Date: 18 March 2017

Please cite this article as: S.M. Hama, Improving Mechanical Properties of Lightweight Porcelanite Aggregate Concrete Using Different Waste Material, *International Journal of Sustainable Built Environment* (2017), doi: http://dx.doi.org/10.1016/j.ijsbe.2017.03.002

Improving Mechanical Properties of Lightweight Porcelanite Aggregate Concrete Using Different Waste Material

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Abstract

Improving the mechanical properties of lightweight concrete using waste material is the goal of this work to get both structural and environmental advantage beside of cost saving. Porcelanite aggregate was used as lightweight aggregate. First plastic bottles were cut to slice and using as fibers with these percentage: 0.0%, 0.5%, 0.75%, 1.0%, 1.25% and 1.5% by volume. The results of tests under compression and tensile stress showed that mix 1% plastic fiber (PF) gave the best results with compared to reference mix without PF. Eggshell (rich with CaO) and glass wastes (rich of silca) were crashed and powdered to desired size and used as partial replacement of cement with these percentage: 0%, 5%, 10%, 15% and 20%. Compressive strength, flexural strength, density, absorption and modulus of elasticity were tested. Comparison was made with reference mix (without waste powder) to figure the efficiency of cooperating these waste in lightweight Porcelinate concrete. The results of tests showed that mixes with 1% PF and 5% eggshell powder (ESP) gave results so close to reference mix. Using more than 5% ESP made non improving in lightweight concrete. While the mix with 1% PF with any glass powder (GP) percentages used in this research gave good improvement in the tested properties especially at 20% GP.

Keywords: Porcelanite, lightweight concrete, eggshell powder, glass powder, plastic fiber

1. Introduction

The utilization of lightweight aggregate in concrete is mainly to reduce the self-weight of concrete, which leading to reduce the dimension of foundation and that results in cost saving. According to ACI committee 213 Structural Lightweight Concrete (SLWC) defined as a concrete with an air-dried density at 28 days in the range of 1120 and 1920 kg/m^3 and a compressive strength above 17.2 MPa. In 1986 an investigations were taken place by the State Company of Survey and Mining which led to discovere Porcelanite rocks in Traifawi in the Iraqi Western Desert, near Rutba (Bassam et.al., 1986). Many studies were made to discover its mineral and chemical properties, as well as estimating reserve of this rocks. Depending on these studies, the State Company of Survey and Mining recommended using Porcelanite as a lightweight coarse aggregate in concrete (Kdair and Aboud, 1993).

AL-Rawi investigated the properties of Porcelanite concrete with cement content between 272-687 kg/m^3, water cement ratios from 0.65 to 1.6 and a strength ceiling up to 32 MPa. An air dry density of 1815 kg/m^3 were observed (AL-Rawi, 1995). While AL-Dhaher produced lightweight concrete using Porcelanite with density between 1400–1960 kg/m^3 and 28 days compressive strength between 13.0–22.4 MPa (AL-Dhaher, 2001). Al-Duleimy studied the effect of addition of superplasticizer and SBR on some properties of Porcelanite lightweight