Institute of Environmental Studies
& Research

STUDIES ON HIGH PERFORMANCE NON-CONVENTIONAL BUILDING MATERIALS CONTAINING SOME SOLID WASTES

A Thesis Presented by

Omaima Mohamed El-Morsy Zarad

(M.Sc. in Environmental Science, 2009)

As

A partial fulfillment for the Ph.D. Degree. in Environmental Science

To

Department of Environmental Basic Science
Institute of Environmental Studies & Research
Ain Shams University

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APPROVAL SHEET

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A thesis submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
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Dedication

To My Fathers Soul and to My Mother to all my Family

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First and foremost, I would like to thank **Allah** for giving me the opportunity and the strength to accomplish this work.

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Finally, I send special thanks and dedicate this work to my mother and my family for the gift of years of support, tolerance and patience. So, I ask my God to aid me to restore even some of them efforts.

Omaima Zarad

LIST OF ABBREVIATIONS

Symbol	Description
OPC	Ordinary Portland cement
GGBFS	Ground granulated blast-furnace slag
CKD	Cement kiln dust
NK	Nano-kaolin
NMK	Nano metakaolin
RHA	Rice-husk-ash
SF	Silica fume
C_3S	Tricalcium silicate (Alite)
β-C_2S	β-dicalcium silicate (Belite)
C-S-H	Calcium silicate hydrate
CH	Calcium hydroxide
XRD	X-ray diffraction
TGA	Thermogravimetric analysis
SEM	Scanning electron microscope

ABSTRACT

The object of this investigation is to study the possible production of autoclaved building products using several industrial solid wastes, produced as by-products from certain industries, as pozzolanic materials activated by two alkaline activators. The alkaline activators used are cement kiln dust (CKD) (the solid waste produced from cement industries using the "dry process") and hydrated lime [$Ca(OH)_2$]. The pozzolanic materials used in this investigation are ground granulated blast-furnace slag (GGBFS) (the solid waste produced from big iron industries), rice husk ash (RHA) (as a source of active silica obtained by burning of rice husk), nano-metakaolin (NMK) (as an active pozzolanic material obtained by burning of nano-kaolin followed by activation at 800 ^{o}C) and silica fume (SF) (as a sort of nano-silica obtained from silicon and ferro-silicon industries) where it condensed from the exhaust gases in the electric arc furnace during reduction of quartz).

Several dry mixtures were prepared and subjected to steam under hydrothermal conditions in the autoclave at a pressure of 8 atmospheres of saturated steam for different curing ages of 0.5 , 2, 6, 12 and 24 hours. The autoclaved specimens were examined for their mechanical properties (compressive strength test) and the crushed samples were ground for other physico-chemical studies; where they are characterized using X-ray diffraction analysis (XRD), thermogravimetric analysis (TGA/DTGA) and scanning electron microscopy (SEM) as well as kinetics of hydration via the determination of chemically combined water (Wn., %) and free lime contents at different autoclaved ages. From the results obtained it was found that the autoclaved products obtained from the pastes made of mixes F1 [(60 % GGBFS - 40 % CKDusing 5 %silica fume as an additive) and F2 [(60 % GGBFS - 40 % CKDwith10 %silica fume as an additive. Therefore, the autoclaved products obtained from these mixes possess higher mechanical properties and improved physico-chemical characteristics as compared to other autoclaved mixes. The main conclusions derived from the results of this investigation revealed that these autoclaved mixes (F1 and F2) represent the optimum constitution of autoclaved building products obtained from the wastes solid industrial.

Keywords: Ground granulated slag, Fly ash, Pozzolanic reaction, Cement Kiln dust, Nano-metakaolin.

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