بسم الله الرحمن الرحيم

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Ain Shams Univeristy
Faculty of Science
Chemistry Department

Physico-chemical characteristics of Geopolymer cement prepared from some Industrial solid wastes

A Thesis Submitted for

Ph.D. Degree in Chemistry

By

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AIN SHAMS UNIVERSITY
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Amira Abd El-Moneam El-Saman Mahmoud

LIST OF ABBREVIATIONS

Abbreviation	Item
C_3S	Tricalcium silicate (Alite)
$\beta - C_2S$	β – dicalcium silicate (Belite)
C_3A	Tricalcium aluminate (valuminate)
C_4AF	Tetracalciumaluminoferrite
WBCSD	World Business Council for Sustainable Development
SCM	Supplementary cementitious materials
OPC	Ordinary Portland cement
FA	Fly ash
GGBFS	Ground granulated blast-furnace slag
SiO_4	Silicate
AlO_4	Aluminate
H	Homra
MD	Marble dust
GP	Granite powder
XRD	X-ray diffraction
FTIR	Fourier transform infrared
SEM	Scanning electron microscopy
POFA	Palm oil fuel ash
RHA	Rice husk ash
NCB	Non-cement binder
PC	Portland cement
AAS	Alkali-activated slag
SEM-EDS	Scanning Electron Microscopy-Energy Dispersive x-ray spectroscopy
UWR	Ultrasonic wave reflection
HSW	Hanford secondary waste
HMNS	High-magnesium nickel slag
CW	Ceramic waste
RCBW	red clay brick waste
CoW	concrete waste
SCGC	Self Compacting Geopolymer Concrete
GRAC	Geopolymeric recycled aggregates concretes
UCS	Unconfined compressive strength
CNASH	Calcium sodium aluminum silicate hydrate
FAGP	Fly ash-based geopolymer
UPV	Ultrasonic pulse velocity

RCPT	Rapid chloride permeability test
ASR	Alkali-silica reaction
GMs	Geopolymer mortars
MK	Metakaolin
MR	Molar ratio
PCM	Portland cement mortar
HPAASC	High Performance Alkali Activated Slag Concrete
EAF slag	Electric Arc Furnace slag
SS	Sodium silicate
SH	Sodium hydroxide
GPC	Geopolymer cement
AAA	Alkali activated aluminosilicate
GW	Granite waste
CDG	Completely Decomposed Granite
MSWI	Municipal solid waste incineration
SCC	Self-compacting concrete
WMD	Waste marble dust
WMDCs	Waste marble dust added cements
WMP	Waste marble powder
ANOVA	Analysis of variance technique
GCMs	Geopolymer composite pastes
SF	Silica fume
PFA	Pulverized fuel ash
CBA	Combustion coal bottom ash
FBC	Fluidized bed combustion
AAGU	Alkaline activated ground steel slag-ultrafine palm oil fuel ash
AAB	Alkali-activated binder
AFS	Alkali-activated fly ash/slag
GGF	Ground Glass Fiber
GLP	Glass-Powder
GLSS	Granulated lead smelter slag
POC	Palm oil clinker
OPS	Oil palm shell
GM	Geopolymer mortar
WS	Wollastonite
TR	Tremolite
SBF	Short basalt fiber
AAM	Alkali-activated materials
CFBC	Circulating fluidized bed combustion
ISO	International Standards Organization

TGA	Thermo-gravimetric analysis
PMs	Pozzolanic solid wastes
FWC	Free water content
CSH	Calcium silicate hydrate
UTM	Universal Testing Machine
FESEM	Field emission scanning electron microscope
PAM	Polyacrylamide
PEG	Polyethylene glycol
MIP	Mercury intrusion porosimetry

Physico-chemical characteristics of Geopolymer cement prepared from some Industrial solid wastes

Abstract:

Physico-chemical characteristics of Geopolymer cement prepared from solid wastes such as slag, Homra, granite powder and marble dust were investigated by determination of setting time, compressive strength, water absorption, mass change, XRD analysis, FTIR spectroscopy, thermal resistance, durability test and microstructure investigation by using SEM. The different geopolymer cement pastes used in this study were ground granulated blast-furnace slag (GGBFS), GGBFS replaced with 10%, 20% and 30% homra, replaced with 10% and 20% granite powder and replaced with 10% and 20% marble dust. Each mix is activated by using a combination between sodium silicate solution and sodium hydroxide solution, in different five ratios. Mixes with highest compressive strength were chosen to study the phase compositions, attached functional groups and microstructures, also it were selected to test their resistance against exposure to 5% magnesium sulfate solution and test their thermal resistance. The LSS:LSH ratio equal one is the best ratio used in this investigation . The results of compressive strength, water absorption, mass change and X-ray diffraction analysis were correlated to a good degree. The degree of durability of the geopolymer cement is evaluated by determining the resistance to sulfate attack after time intervals extended up to 180 days. The thermal resistance is carried out by firing the specimens at 200, 300 and 600 ^{o}C for 3hrs, and determine compressive strength and loss of weight at each treatment temperature.

Key words: Geopolymer cement, granite powder, marble dust, homra, geopolymerization and supplementary cementituos materials.