ENVIRONMENTAL IMPACTS OF IRON SLAG AND ITS UTILIZATION FOR IMPROVEMENT OF ROAD BASES

Submitted By

Mohamed Ahmed Mohamed Gharieb Mwafy

B.Sc. of Science (Chemistry/Biochemistry), Faculty of Science,
Alexandria University, 2003

A thesis submitted in Partial Fulfillment
Of
The Requirement for the Master Degree
In
Environmental Sciences

Department of Environmental Basic Sciences
Institute of Environmental Studies and Research
Ain Shams University

2017

APPROVAL SHEET

ENVIRONMENTAL IMPACTS OF IRON SLAG AND ITS UTILIZATION FOR IMPROVEMENT OF ROAD BASES

Submitted By

Mohamed Ahmed Mohamed Gharieb Mwafy

B.Sc. of Science (Chemistry/Biochemistry), Faculty of Science,
Alexandria University, 2003

A thesis submitted in Partial Fulfillment
Of
The Requirement for the Master Degree
In
Environmental Sciences
Department of Environmental Basic Sciences

This thesis Towards a Master Degree in Environmental Sciences

Has been approved by:

Name Signature

1-Prof. Dr. Samir Ahmed Awad
Prof. of Geology, Department of Geology
Faculty of Science
Ain Shams University

2-Prof. Dr. Ali I. M. Ismail
Prof. of Engineering Geology, Department of Geology
National Research Center

3-Prof. Dr. Hassan Hassanein Darwish
Prof. of Technological & Building Materials Engineering
National Research Center

4-Prof. Dr. Laila Abd El Megid Fayed
Prof. of Engineering Geology
Faculty of Science
Cairo University

2017

ENVIRONMENTAL IMPACTS OF IRON SLAG AND ITS UTILIZATION FOR IMPROVEMENT OF ROAD BASES

Submitted By

Mohamed Ahmed Mohamed Gharieb Mwafy

B.Sc. of Science (Chemistry/Biochemistry), Faculty of Science,
Alexandria University, 2003

A thesis submitted in Partial Fulfillment
Of
The Requirement for the Master Degree
In
Environmental Sciences
Department of Environmental Basic Sciences

Under The Supervision of:

1-Prof. Dr. Samir Ahmed Awad
Prof. of Geology, Department of Geology
Faculty of Science
Ain Shams University

2-Dr. Ali I. M. Ismail
Associate Prof. of Engineering Geology, Department of Geology
National Research Center

2017

ACKNOWLEDGMENTS

First words and foremost thanks to Allah, the most beneficent and merciful.

I would like to sincerely thank my supervisor **Dr. Professor. Ali Ismael** for his guidance throughout the supervision of this work , his valuable comments during the writing up and his critical comments during the analytical tests. I would like also to thank **Dr. Professor. Samir Awd**, for supervising the work, his continuous encouragement and faithful discussion during the progress of the work covered by the present thesis.

Grateful thanks to my dear general manger **Mr. Abdallah Nassar** (General Director of Mineralogy and Geochemistry, EMRA), for his effective help and encouragement, also a special thanks to my dear manger **Mr. Medhat Ali Abd Al Raziq** (Director of Mineralogy, EMRA), for his help and faithful discussion in the chemical part of the environmental applications.

My special thanks and acknowledgement are due to my Father, Mother and my brothers Mr. Eslam and Dr. Basem for their moral support and encouragement, who made this research· possible. My thanks also are due to my sincere wife and my daughter **Jana** and my son **Yahya** for their patience and encouragement during the research period.

Thank you very much!

CURRICULUM VITAE

Name **:** Mohamed Ahmed Mohamed Gharieb Mwafy

Date of birth **:** 10 / 1 / 1983

Nationality **:** Egyptian.

Mobile **:** 00201002064987

Qualification **:** B.Sc. of Science (Alex. University) 2003, with general grade (Very Good)**.**

Specification: Chemistry and Bio chemistry.

Current Job **:** Chemist in Egyptian Mineral Resources Authority.

Experience **:** Chemist in the Department of Mineralogical and Geochemical Studies in the "Central Laboratories Sector of Egyptian Mineral Resources Authority".

E-mail address: dr.mwafy@yahoo.com , mmwafy2017@gmail.com

TO

MY

FATHER

ABSTRACT

MSC. Thesis:

Name of Student: Mohamed Ahmed Mohamed Gharieb Mwafy
Thesis title : Environmental impacts of iron slag and its utilization for improvement of road bases

In this study Electric arc furnace (EAF) slag is utilized in two applications, namely the improvement of engineering properties of soil materials (problematic soil stabilization) and in blended cement. In Egypt, there is found that a very small percentage of EAF slag was utilized in engineering purposes, although, on the other hand a huge quantity of EAF slag was accumulated. In order to validate this application, a series of tests have been carried out to determine the environmental impact such as chemical and mineral composition, boiling test, pH, and leaching test for the different cooling rates EAF slag.

From the chemical analysis results, it is shown that all heavy metals in EAF slag except V and Cr are found to be very low and insignificant in term of environmental impacts. The cooling rate affects significantly the leaching of Cr, without a significant relation of the original slag Cr content.

Various mixes (up to 20% EAF slag by dry weight of the test soil) with or without lime are used in this study. The investigations showed that free swelling improved by increasing the addition of EAF slag till 10% EAF slag and then remain constant, and the percent of improving varied according to the cooling rate of EAF slag, where the water cooled slag decrease the free swelling more than the air cooled slag. The addition of lime resulted in a dramatic improvement in the free swelling.

By comparing the effect of the two different cooling rates of EAF slag (up to 10% by dry weight) on the properties of the concrete pastes after 28 days of curing are carried out in this study. XRD, SEM, density, pH and compressive strength results show that the water (rapid) cooled EAF slag causes a marked improvement in the mechanical properties for the hardened pastes.

Keywords: Electric arc furnace slag, Soil stabilization, Concrete pastes, Environmental impacts.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

LIST OF FIGURES