IMPROVING OF BASE COURSE MATERIALS CHARACTERISTICS USING INDUSTRIAL WASTES

A Thesis
Submitted to the Public Works Department
Faculty of Engineering
Ain Shams University
For partial Fulfillment for the Requirements of
The Master of Science Degree
In Civil Engineering (Highways and Traffic)

Prepared by

Eyas Mohammed Eyad Almallouhi
B.Sc. in Civil Engineering, 2016
Higher Institute of Engineering and Technology El-Arish

Supervisors

Prof. Dr. Hassan Abdul Zaher Mahdy
Professor of Highway and Traffic Engineering
Faculty of Engineering, Ain Shams University, Cairo, Egypt

Prof. Dr. Khaled Anwar Kandil
Professor of Highway and Airports Engineering
Faculty of Engineering, Ain Shams University, Cairo, Egypt

Cairo, 2019

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Thesis Approval

Examinar Committee	**Signature**
Prof. Dr. Hassan Tahssin Abdul Wahab Professor of Highway and Airports Engineering Faculty of Engineering, Cairo University	....
Prof. Dr. Eissa Abdul Allah Srhan Professor of Highway and Traffic Engineering Faculty of Engineering, Ain Shams University	....
Prof. Dr. Hassan Abdul Zaher Mahdy Professor of Highway and Traffic Engineering Faculty of Engineering, Ain Shams University	....
Prof. Dr. Khaled Anwar Kandil Professor of Highway and Airports Engineering Faculty of Engineering, Ain Shams University	....

Date: .. .. /.. ../ 2019

Dedication

This thesis is dedicated to those who contributed to educating, encouraging and supporting me to be able to fulfill this work…

To my Father and my Mother…

To my Brothers and my Sisters…

Researcher Data

Name:	Eyas Mohammed Eyad Almallouhi
Date of Birth:	1 / 1 / 1993
Place of Birth:	Homs – Syria.
Nationality:	Syrian.
Last Academic Degree:	B.Sc. in Civil Engineering
Awarding Date:	2016
Department:	Road and Airport
University issued the degree:	Higher Institute of Engineering and Technology El-Arish

Statement

This thesis is submitted for the partial fulfillment of Master of Science degree in Civil Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis and no part of it has been submitted for a degree or qualification at any other scientific entity.

Name

Eyas Mohammed Eyad Almallouhi

Signature

………………………………..

Date

……./……. /2019

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Abstract

Phosphogypsum is a solid by-product waste generated from phosphoric acid industry. The worldwide amount of phosphogypsum is ranging between 100 and 280 million tons. Otherwise, iron and steel slag is a solid by-product waste resulted from iron and steel industry. The estimated worldwide amount of iron and steel slag is 400 million tons. Therefore, these solid wastes are causing negative effect on the environment and surrounding communities. On the other hand, the demand for road construction, widening and maintenance works also construction of other structures increased by time, which means increasing in demand for conventional aggregates that threatened by depletion. Therefore, many studies were conducted around the world by utilizing these solid by-product wastes in road construction which proved the ability to use these wastes either with underlying layers or asphaltic layers. This study aims to form and test mixtures of these wastes with locally available traditional base course aggregates to determine and evaluate the effect of adding these solid wastes on some of mechanical characteristics of the base course materials. Therefore, all used materials subjected to validation tests to determine some of its physical and mechanical characteristics. Seven percentages (0, 5, 10, 15, 20, 25 and 30%) of phosphogypsum were mixed with crushed limestone. Further, three percentages (25, 50 and 75%) of crushed steel slag blended with crushed dolomite stone and six percentages (0, 5, 7.5, 10, 12.5 and 15%) of phosphogypsum at each percent of steel slag. These mixtures subjected to modified compaction test, un-soaked California bearing ratio penetration test, soaked California bearing ratio penetration test, California bearing ratio swelling test and California bearing ratio penetration test after a series of wetting-drying cycles. The results of tests demonstrated that using phosphogypsum and crushed steel slag improves some mechanical characteristics of traditional base course materials. Whereas, a mixture containing 20% phosphogypsum and 80% crushed limestone showed improving in some mechanical characteristics comparing with control mix 100% crushed limestone. Further, some mechanical characteristics of a mixture consisting 10% phosphogypsum from mixture dry weight, crushed steel slag and crushed dolomite stone with ratio 75%:25% were enhanced compared with control mix 100% crushed dolomite stone. Therefore, utilizing these solid by-product wastes in road base enhance the mechanical properties of conventional construction aggregates.

Key words: phosphogypsum, steel slag, limestone, dolomite stone, California bearing ratio, wetting-drying cycles and base course.

Acknowledgement

All thanks and praise be to **Allah**, the Almighty, for his unnumbered and countless blessing and gifts, the thanks is attached to my **father** and my **mother** for every things they gave it to me, the thanks is linked to my **brothers** and my **sisters** for their endless encouragement and support.

Further, I grant Great thanks to my supervisors Prof. Dr. Hassan Abdul Zaher Mahdy Professor of Highway and Airports Engineering, Ain Shams University and Prof. Dr. Khaled Anwar Kandil Professor of Highway and Airports Engineering, Ain Shams University, for their help, cooperation and instructions during preparing of this study.

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List of abbreviations

PG	Phosphogypsum
CLS	Crushed limestone
CSS	Crushed steel slag
CDS	Crushed dolomite stone
CBR	California bearing ratio
W-D	Wetting - drying
BT	Billion ton
MT	Million ton
DHPG	Dehydrate phosphogypsum
HHPG	Hemihydrate phosphogypsum
TENOM	Technologically enhanced naturally occurring material
UCS	Unconfined compressive strength
AASHTO	American association of state highway and transportation official
Psi	Pascal per square inch
Kpa	Kilo Pascal
Mpa	Mega Pascal
USGS	United States geological survey
BF	Blast furnace
LF	Ladle furnace
BOF	Basic oxygen furnace
EAF	Electric arc furnace
IS	Iron slag
SS	Steel slag
BFS	Blast furnace slag
BOFS	Basic oxygen furnace slag
EAFS	Electric arc furnace slag
LFS	Ladle furnace slag
ACBFS	Air cooled blast furnace slag
EBFS	Expanded blast furnace slag
PBFS	Pelletized blast furnace slag
GBFS	Granulated blast furnace slag
GGBFS	Ground granulated blast furnace slag
LA	Los Angeles
OMC	Optimum moisture content
MDD	Maximum dry density