TREATMENT OF EXPANSIVE FOUNDATION SOILS USING EXTRUDED POLYSTYRENE (XPS) GEOFOAM AND EXPANDED POLYSTYRENE (EPS) BEADS

BY

Engineer \ Ibrahim Fawzy Ibrahim El-Demary

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY
In
CIVIL ENGINEERING - PUBLIC WORKS

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT

2017

TREATMENT OF EXPANSIVE FOUNDATION SOILS USING EXTRUDED POLYSTYRENE (XPS) GEOFOAM AND EXPANDED POLYSTYRENE (EPS) BEADS

BY

Engineer \ Ibrahim Fawzy Ibrahim El-Demary

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY
In
CIVIL ENGINEERING - PUBLIC WORKS

Under the Supervision of

Prof. Dr. Moustafa A. Abu Kiefa

Professor of Geotechnical Engineering
Soil Mechanics and Foundations
Research Laboratory
Faculty of Engineering, Cairo University

Prof. Dr. Laila S. Radwan,

Professor of Highway, Airports and
Traffic Engineering
Faculty of Engineering, Cairo University

Dr. Rami M. El Sherbiny

Associate Professor of Geotechnical Engineering
Soil Mechanics and Foundations Research Laboratory
Faculty of Engineering, Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2017

TREATMENT OF EXPANSIVE FOUNDATION SOILS USING EXTRUDED POLYSTYRENE (XPS) GEOFOAM AND EXPANDED POLYSTYRENE (EPS) BEADS

BY

Engineer \ Ibrahim Fawzy Ibrahim El-Demary

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY
In
CIVIL ENGINEERING - PUBLIC WORKS

Approved by the Examining Committee:

Prof. Dr. Moustafa A. Abu Kiefa, Thesis Main Advisor

Prof. Dr. Laila S. Radwan, Advisor

Dr. Rami M. El Sherbiny, Advisor

Prof. Dr. Abdelsalam M. Salem, Internal Examiner

Prof. Dr. Khalid M. El-Zahaby, External Examiner
Chairman of Housing and Building National Research Center

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2017

Engineer: Ibrahim Fawzy Ibrahim El-Demary
Date of Birth: 10 / 9 / 1977
Nationality: Egyptian
E-mail: Ibrahim_Eldemary@ Yahoo.com
Phone.: 01147843491
Address: 36 Elemam Abu hanifia 7th District
Nasr City

Registration Date: 1 / 10 / 2010
Awarding Date: / / 2017
Degree: DOCTOR OF PHILOSOPHY
Department: Civil Engineering - Public Works

Supervisors: Prof. Dr. : Moustafa A. Abu Kiefa
Prof. Dr. : Laila S. Radwan
Dr. : Rami M. El Sherbiny

Examiners: Prof. Dr. : Moustafa A. Abu Kiefa
Prof. Dr. : Laila S. Radwan
Dr. : Rami M. El Sherbiny
Prof. Dr. : Abdelsalam M. Salem, Internal Examiner
Prof. Dr. : Khalid M. El-Zahaby, External Examiner
Chairman of Housing and Building National Research Center

Title of Thesis: Treatment of Expansive Foundation Soils Using Extruded Polystyrene (XPS) Geofoam and Expanded Polystyrene (EPS) Beads

Key Words: Expansive soil, swelling pressure, swelling strains, XPS geofoam**,** EPS beads

Summary: Swelling pressures and strains are induced when expansive soils swell vertically and laterally as their moisture content increases damaging structures and roadways. The main purpose of this research is to study the effect of polystyrene geofoam in reducing vertical swelling pressure and strain. Three synthetic expansive soils were used. Expanded polystyrene EPS beads and extruded polystyrene XPS geofoam were utilized in the study. Three treatment techniques were used in the study which were inserting cylindrical cores of XPS within the expansive soil mass, filling holes with EPS beads and mixing EPS beads with the expansive soil. The XPS core insertions and the holes filled with EPS beads are newly proposed approaches. The diameters of the XPS cores and the holes filled with beads were 5, 10 and 15 mm while the mixing contents of EPS beads were 0.1, 0.2 and 0.3 %. Small and large oedometer were used in testing. Results of XPS inserts showed a reduction in vertical swelling pressure and strain of up to 40.8 and 50.2 %, respectively, while the holes filled with beads reduced the vertical swelling pressure and strain by 66.2 % and 79.0 % respectively. The EPS beads – soil mixtures achieved a reduction of 100 % for both parameters.

ACKNOWLEDGMENT

First of all, the most gratitude to ALLAH who guided me to complete this work.

I would like to express and record my deepest appreciation and great thanks to my thesis supervisors ***Prof. Dr. Moustafa Abu Kiefa, Prof. Dr. Laila Radwan and Dr. Rami El Sherbiny*** who throughout their supervision provided me with valuable suggestions, guidance, support and continuous encouragement.

I would like to thank all members of the Soil Mechanics and Foundations Research Laboratory, Faculty of Engineering, Cairo University, for their great assistance during my work.

I would like to state my sincere gratitude to ***Prof. Dr. Mamdouh Hamza*** for providing access to facilities at HAMZA ASSOCIATES office for this research.

Finally, I would like to dedicate this thesis to my mother.

Ibrahim Fawzy

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES