بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

MONA MAGHRABY

APPROPRIATE DRAIN ENVELOPE FOR PROBLEMATIC CALCAREOUS SOILS IN EGYPT

By

Omar Badr Mohamed Badr

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Irrigation and Hydraulics Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2020

APPROPRIATE DRAIN ENVELOPE FOR PROBLEMATIC CALCAREOUS SOILS IN EGYPT

By

Omar Badr Mohamed Badr

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Irrigation and Hydraulics Engineering

Under the Supervision of

Prof. Dr. Abdallah S. Bazaraa

……..

Professor
Department of Irrigation and Hydraulics
Faculty of Engineering, Cairo University

Dr. Gehan A.H. Sallam

……..

Associate Professor
Drainage Research Institute (DRI)
National Water Research Center (NWRC)

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2020

APPROPRIATE DRAIN ENVELOPE FOR PROBLEMATIC CALCAREOUS SOILS IN EGYPT

By

Omar Badr Mohamed Badr

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Irrigation and Hydraulics Engineering

Approved by the
Examining Committee

_____
Prof. Dr. Abdallah Sadik Bazaraa (Thesis Main Advisor)

_____
Prof. Dr. Kamal EL-Deen Milad Soliman (Internal Examiner)

_____
Prof. Dr. Osama Khairy Saleh (External Examiner)
(Faculty of Engineering, Zagazig University)

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2020

Engineer's Name: Omar Badr Mohamed Badr
Date of Birth: 16/1/1991
Nationality: Egyptian
E-mail: Omarwho45@gmail.com
Phone: 01142738778
Address: El-kanater .El-khairya , Quliubiya, Cairo
Registration Date: 1/3/2016
Awarding Date: …./…./……..
Degree: Master of Science
Department: Irrigation and Hydraulics Engineering

Supervisors:

Prof. Abdallah S. Bazaraa
Dr. Gehan A.H sallam (Associate Professor at DRI-NWRC)

Examiners:

Porf. Abdallah Sadik Bazaraa (Thesis main advisor)
Prof. Dr. Kamal EL-Deen Milad Soliman (Internal examiner)
Prof. Dr. Osama Khairy Saleh (External examiner),
(Faculty of Engineering, Zagazig University)

Title of Thesis:

APPROPRIATE DRAIN ENVELOPE FOR PROBLEMATIC CALCAREOUS SOILS IN EGYPT

Key Words:
subsurface drainage; envelope materials; calcareous soils; permeameter test

Summary:

Agricultural subsurface drainage systems are commonly used to remove the excess water and salts from the root zone to enhance crop production and to ensure irrigated agriculture sustainability. In Egypt, drain pipes installed in soils with limited cohesion (clay content is less than 30%) should be provided with envelopes to prevent the entry of soil particles into the drains (filter function) and to reduce entrance resistance by creating a more permeable zone around drains (hydraulic function). Calcareous soils with calcium carbonate (CaCO3) content of more than 15% are considered hazardous problematic soils that cause envelope clogging and sedimentation in the subsurface drainage network. Earlier testing of synthetic drain envelopes in Egyptian calcareous soils has revealed poor performance. Therefore, the main objective of this study is to determine the most appropriate locally available envelope material(s) that can be used in calcareous soils under Egyptian conditions. Both theoretical and experimental (laboratory as well as field) investigations were conducted to assess the performance of the locally available synthetic envelope (polypropylene with pore size 400 microns – PP400) alone and combined with granular materials. The assessment results (theoretical and experimental) indicated that the currently used synthetic envelope PP400 is not performing well when used alone (too thin with low porosity). Treatments that have a gravel material, either alone or in combination with the locally available synthetic envelope revealed good performance and consequently gravel envelopes alone are recommended.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Omar Badr Mohamed Badr Date:

Signature:

Acknowledgments

I would like to thank my supervisors, Prof. Abdallah S. Bazaraa of Cairo University, and Dr. Gehan Sallam of the Drainage Research Institute, for their extensive care and interest in leading my work and guiding me dedicatedly to this point.

I would also want to thank the Drainage Research Institute (DRI) directors and staff, Specially Dr. Mohamed Bakr Abd El-Ghany, for his endless help and support, in gathering the required data and providing me with the required information.

Above all, thanks are extended to my family, especially my father, my mother, and my beloved wife for their continuous motivation and encouragement, that played the most supportive and helpful role during my research, allowing me always to work harder and be more efficient. I wouldn’t have reached what I have reached without them.

Last but not least, I would like to thank all of my friends and colleagues inside and outside the DRI for their extensive support and encouragement.

Table of Contents

List of Tables

List of Figures

Nomenclature

ae	The ratio of the perforated pipe surface area exposed to water flow
cm	Centimeter
Cu	Coefficient of uniformity, which is the ratio between d_{60} and d_{10}
d_{10}	Particle size of the base soil at which 10% of the material has a smaller size (microns)
d_{60}	Particle size of the base soil at which 60% of the material has a smaller size (microns)
d_{90}	Particle size of the base soil at which 90% of the material has a smaller size (microns)
DRI	Drainage Research Institute
DRP	Drainage Research Programme Project
EPADP	Egyptian Public Authority for Drainage Projects
FAO	Food and Agriculture Organization of the United Nations
Fed	Feddan = 4200 m2
he	Entrance head loss (m)
HFG	Hydraulic failure gradient (dimensionless)
I_{ex}	Hydraulic exit gradient (dimensionless)
K	Soil saturated hydraulic conductivity (m/d)
m/d	Meter per day
NWRC	National Water Research Center
O_{90}	pore size at which 90% of the envelope pores have an equal size or smaller (microns)
PADTP	The Drainage Technology and Pilot Areas Project
PI	The plasticity index of the soil and is equal to the difference between the liquid limit and the plastic limit of the soil.
PSD	The soil particle size distribution
PVC	Polyvinyl chloride
Q	The drain discharge (m^3/day)
re	Entrance resistant (day/m)
ε	Porosity of synthetic (voluminous) envelope (dimensionless)