بسم الله الرحمن الرحيم

∞∞∞

تم رفع هذه الرسالة بواسطة / سلوي محمود عقل

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات: لا يوجد

DESIGN OF GEOPOLYMER COMPOSITES FOR 3D PRINTING APPLICATIONS

By

Passant Ahmed Mohamed Mohamed Youssef

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
Structural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2022

DESIGN OF GEOPOLYMER COMPOSITES FOR 3D PRINTING APPLICATIONS

By
Passant Ahmed Mohamed Mohamed Youssef

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
Structural Engineering

Under the Supervision of

Prof. Dr. Ahmed M. Ragab

………………………………………

Professor of Strength of Materials
Civil Department
Faculty of Engineering, Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2022

DESIGN OF GEOPOLYMER COMPOSITES FOR 3D PRINTING APPLICATIONS

By
Passant Ahmed Mohamed Mohamed Youssef

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
Structural Engineering

Approved by the
Examining Committee

____
Prof. Dr. Ahmed Mahmoud Maher Ragab, Thesis Main Advisor

____
Prof. Dr. Osama Abdel-Ghafour Hodhod, Internal Examiner

____
Dr. Muhammad Samy El-Feky, External Examiner
- Assistant Professor, Civil Engineering Department, National Research Center

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2022

Engineer's Name: Passant Ahmed Mohamed Mohamed Youssef
Date of Birth: 20/09/1990
Nationality: Egyptian
E-mail: passant.youssef@yahoo.com
Phone: 002-0128-521-9445
Address: No. 49, El-Oroba St., Haram, Giza, Egypt.

Registration Date: 01/10/2016
Awarding Date: …./…./2022
Degree: Doctor of Philosophy
Department: Structural Engineering

Supervisors:

Prof. Dr. Ahmed M. Ragab

Examiners:

Prof. Dr. Ahmed M. Ragab (Thesis main advisor)
Prof. Dr. Osama Abdel-Ghafour Hodhod (Internal examiner)
Dr. Muhammad Samy El-Feky (External examiner)
- Assistant Professor - Civil Engineering Department - National Research Center

Title of Thesis:

Design of Geopolymer Composites for 3D Printing Application

Keywords:

Slag; Metakaolin; Geopolymer; 3D Printing; Additive Manufacturing

Summary:

The overall objective is to propose a design methodology for a geopolymer concrete mix that can be used in the 3D printing process. The effect of size and type of fine aggregate, type of binder (either slag or metakaolin) and ratio (slag: metakaolin) and quantity and proportion of alkali solution (NaOH: Sodium Hydroxide) was studied. Sodium silicate) on the specified setting time and mechanical strength development according to the technical specifications of the 3D printing machine and finally improving the workability, extrusion and open time to achieve the flowability, shape retention and buildability of geopolymer composites for 3D printing.

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: Passant Ahmed Mohamed Mohamed Youssef Date: ../../2022

Signature:

Dedication

To my mom

The reason of what I become today; who taught me to trust Allah and believe in myself. Your prayers always surround me and give me the strength to never give up. All the love and respect to you for your support.

To my dad's soul

For the living memory; although I didn't get the chance to live with you these moments, your presence is still felt in my heart and your character imprinted in my personality.

To Prof. Dr. Mohamed I. Serag

I'm grateful for your valuable advice and continuous support during my study. Your immense knowledge and plentiful experience have encouraged me in all the time of my academic research and daily life.

Acknowledgments

To begin, and most importantly, I want to express my gratitude to Allah for this beautiful opportunity that I have right now. I appreciate God for allowing me to meet such friendly and helpful individuals who have aided me from the beginning of my thesis. All gratitude is due to Allah to bestow the knowledge, strength, support, and patience necessary to complete this job.

I want to convey my heartfelt appreciation to my respected supervisor, Prof. Dr. Ahmed M. Ragab, for the privilege of being one of their students. Furthermore, I am grateful for the continual advice and support throughout this thesis and the direction, concern, patience, and considerable effort made to create an ideal environment for doing this study.

I express my gratitude to Dr. Muhammad S. El-Feky for his tolerance, encouragement, and intense concern for the work's efficiency. He provided me with invaluable knowledge and spent much time training me on data collection and thesis writing and making essential ideas concerning the experimental program. I've been fortunate to work under his direction.

I'm thankful to my research team colleague, Dr. Ahmed El-Tair. He had been helpful in providing advice many times during my study. His invaluable assistance and insights leading to the implementation of this experimental program. I'm thankful for providing opportunities for me to grow professionally.

I would also want to convey my heartfelt gratitude to my lovely family members for motivating and encouraging me to continue pursuing my ambitions with their support, love and patience. This journey would not have been possible if not with my family. I'm forever indebted to my parents for giving me the opportunities that have made me who I am. I'm grateful to my sisters for always being there for me. I'm thankful for my husband for encouraging me to explore new directions in life. Thank you all for believing in me; all my love and appreciation for you.

I would like to thank my close friends. They are all my treasure in my life. The emotional support you always give to me is so precious; blessed for having you.

Finally, I would like to express my gratitude for the assistance and efforts of lab technicians who assisted in conducting the experimental thesis work; as well as the German University in Cairo and the National Research Center for providing me with the facilities and manpower necessary to carry out the research experimental plan and enabling me to complete this research.

Table of Contents

List of Tables

List of Figures