شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

HOSSAM MAGHRABY

شبكة المعلومات الجامعية

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

HOSSAM MAGHRABY

شبكة المعلومات الجامعية

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

HOSSAM MAGHRABY

Ain Shams University
Faculty of Engineering
Department of Architecture

The Impact of Using Nanotechnology in Building Envelope Materials on Firefighting in High-rise Buildings

A Thesis Presented in Partial Fulfillment of the Requirements for
Master of Science Degree in Architecture Engineering

2021

By:

Eng. Aya Maher Morsi

B.sc. in Architecture 2016
Faculty of Engineering, Ain Shams University

Under Supervision

Prof. Dr. Akram Farouk Mohamed

Professor of Architecture and Project Management
Ain Shams University

Prof. Dr. Mostafa Refaat Ahmed

Professor of Architecture and Environmental Control
Ain Shams University

Ain Shams University
Faculty of Engineering
Department of Architecture

Name: Aya Maher Morsi Ahmed

Title: The Impact of Using Nanotechnology in Building Envelope Materials on Firefighting in High-rise Buildings

Degree: Master of Science Degree in Architecture

The Jury Committee: **Signature**

Professor Dr. Ehab Mahmoud Okba

Professor of Architecture
Department of Architecture
Faculty of Engineering - Fayoum University

Professor Dr. Ahmed Atef El-Desouky Faggal

Professor of Architecture
Department of Architecture
Faculty of Engineering - Ain Shams University

Professor Dr. Akram Farouk Mohamed

Professor of Architecture and Project Management
Department of Architecture
Faculty of Engineering - Ain Shams University

Professor Dr. Mostafa Refaat Ahmed

Professor of Architecture and Environmental Control
Department of Architecture
Faculty of Engineering - Ain Shams University

Thesis Defense Date …./…./…./….

Post Graduate Studies

Approval Stamp

…./…./….

The Research was approved on

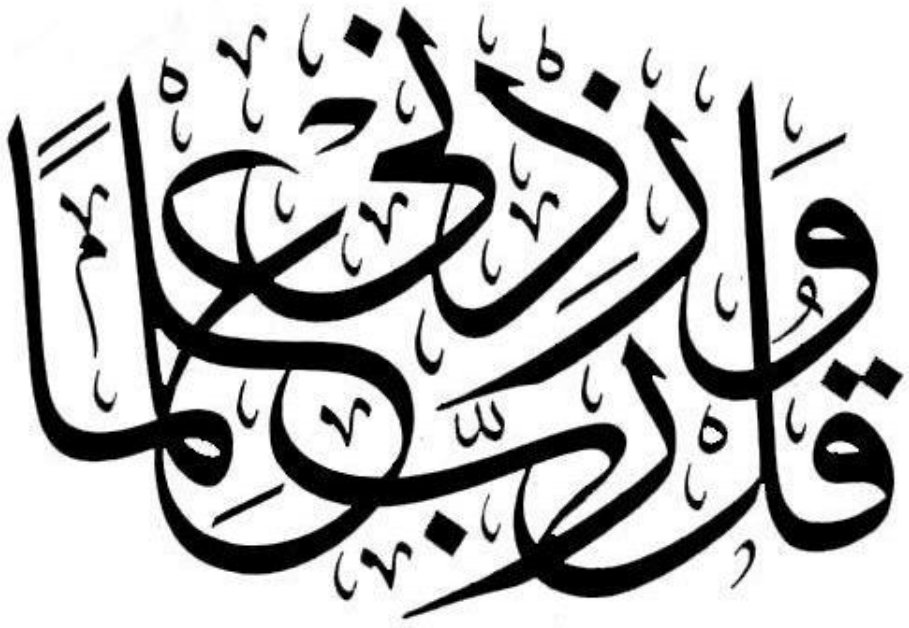
…./…./….

Faculty Council Approval

…./…./….

University Council Approval

…./…./….



Disclaimer

This thesis is submitted as partial fulfillment of M.Sc degree in Architecture, Faculty of Engineering, Ain Shams University.

The work included in this thesis was carried out by the author during the period from November 2017 to November 2020, and no part of it was submitted for a degree or qualification at any other scientific entity.

The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

Name: Aya Maher Morsi
Signature: ……....
Date: …….

Acknowledgment

First of all, I thank God for helping me reach this step and allowing me to do this research.

I want to especially thank my supervisors: ***Prof. Dr. Akram Farouk*** and ***Prof. Dr. Mostafa Refaat*** for their continuous support and their valuable feedbacks which directly and indirectly inspired me through different stages in my thesis process. As well as I would like to thank my jury committee ***Prof. Dr. Ehab Mahmoud Okba*** and ***Prof. Dr. Ahmed Atef Faggal*** for their guidance and insightful comments.

A special thanks to ***Dr. Hassan Salem*** for his valuable course on Pyrosim program which helped me understand the program and take a valuable step in this research.

Also I want to thank ***Eng. Ahmed El Shmandy*** & ***Eng. Ahmed Jkl*** from China State Construction Company for their valuable data which helped me continuing my research.

As Well As, I want to thank my father ***Mr. Maher Morsi***, My Mother ***Mrs. Hanan Essa***, as well as my little sister ***Shahd Maher***; and the rest of my family members for their continuous support and encouragement in my career.

Finally, I want to thank my friends **Aya Mohamed Abdelhai**, **Aya Arafa** and **Aya Hussien** for their continuous support.

Aya Maher Morsi

Abstract

High-rise buildings are a trend in buildings recently as their number is at a rapid increase until this year. And they started to be applied in developing countries like Egypt so we need to focus and study the problems faced by them all over the world and look for a solution to these problems.

Nowadays High-rise buildings' fires due to envelope material have been a noteworthy problem that attracts a lot of media attention due to their high risk and losses among people and property. These fire cases still occur until this year as Abbco Tower in Sharjah, and Business Centre in Ankara, and Madrid tower in Madrid.

This thesis aims to study the components of the different façade typologies to pick out the combustible traditional thermal insulating materials as well as cladding materials. Then by studying some nano-additives, paints, coatings, and thermal insulating materials, they can be used as alternatives for the traditional materials after making a comparison between their fire performance and the traditional envelope materials' to improve the building envelope fire performance.

To obtain the thesis's main objective, three methods will be used; **first**, a literature review will be used to gather data on fire cases in high-rise buildings, existing building envelope materials, and their fire performance in some case studies and this method will be applied in chapter one. **Second**, analytical studies are divided as follows; into qualitative analysis to help in getting new Nanomaterial additives, paints, coatings, and thermal insulations to be an alternative for the existing building envelope materials. Then comparative analysis to help in comparing different materials and then applying some development or replacing the existing ones to reach the best performance against fire using SP 105 fire test as a tool and this method will be applied in chapters two and three. **Third**, simulation method to make a comparison between the fire performance of the existing envelope materials and nano-alternatives by applying SP 105 fire test which was used to judge the validity to use these materials in high-rise buildings' façade by using pyrosim software (version 2019.3.1204, 2002-2020 copyright) as an interface for Fire Dynamic Simulator (FDS) to help to build the model, testing these materials as well as giving graphical results. While smokeview

(version 6.7.7) was used for viewing the results of the realistic simulation and this method will be applied in chapter four.

This thesis concluded that the fire performance of nano-thermal insulating materials is much better than traditional ones. In case of traditional cladding materials, some of them pass the fire test so it can be used in high-rise buildings while the other needs to be treated by some nano-coatings to improve their fire-resistant time. It was also proved that nano-additives sometimes cannot improve the traditional material to pass the fire test.

In the end, this thesis recommends applying this large-scale test on-site and studying other points on the performance of these materials to get internationally certified and also try to found a way to decrease these materials' costs as well as studying these materials impact on human health.

Keywords

High-rise buildings, Large-scale test, Pyrosim, Traditional Façade Materials, Nano-thermal Insulations, Nano-coatings, Nano-additives.

Software Used

The Fire Dynamics Simulator (FDS): is considered as a large-eddy simulation code for low-speed flows, with an emphasis on smoke and heat transport from fires.

Pyrosim: is used as an interface for the FDS to create the model and apply the materials.

Smokeview: is considered as a visualization program that is used to display the realistic output of FDS and Pyrosim.