شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

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HANAA ALY

Ain Shams University
Faculty of Engineering
Structural Engineering Department

Behavior of RC Columns Subjected to Lateral Loads and Strengthened Using NSM Basalt and Glass FRP Bars

A Thesis submitted in partial fulfillment of the requirements for the degree of
Master of Science in Civil Engineering
Structural Engineering Department
by

Eng. Mohamed Mostafa Abdel-Hamid

Bachelor of Science in Civil Engineering
Structural Engineering Department
Faculty of Engineering, Ain Shams University, 2016

Supervised By

Prof. Dr. Yehia Abdel-Zaher
Professor of Properties and Testing of Materials, Structural Department, Faculty of Engineering
Ain Shams University

Dr. Ibrahim Abdel-Latif
Associate Professor, Structural Engineering Department, Faculty of Engineering
Ain Shams University

Dr. Fareed Mahmoud Elgabbas
Assistant Professor, Structural Engineering Department, Faculty of Engineering
Ain Shams University

Cairo - (2022)

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Supervision Committee

Name and Affiliation	**Signature**
Prof. Dr. Yehia Abdel-Zaher Professor of Properties and Testing of Materials, Structural Department, Faculty of Engineering, Ain Shams University	…….....
Dr. Ibrahim Abdel-Latif Associate Professor, Structural Engineering Department, Faculty of Engineering Ain Shams University	…….....
Dr. Fareed Mahmoud Elgabbas Assistant Professor, Structural Engineering Department, Faculty of Engineering Ain Shams University	…….....

Date: 24 January 2022

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Examiners' Committee

Name and Affiliation	**Signature**
Prof. Dr. Osama Abdel-Ghafour Hodhod Professor of Properties and Testing of Materials, Structural Department, Faculty of Engineering, Cairo University	…….....
Prof. Dr. Hany Mohamed Elshafie Professor of Properties and Testing of Materials, Structural Department, Faculty of Engineering, Ain Shams University	…….....
Prof. Dr. Yehia Abdel-Zaher Professor of Properties and Testing of Materials, Structural Department, Faculty of Engineering, Ain Shams University	…….....

Date: 24 January 2022

Statement

This thesis is submitted as partial fulfillment of Master of Science in Civil Engineering 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 a qualification at any other scientific entity.

Mohamed Mostafa Abdel-Hamid Ramadan

Signature

……...……

Date:

Abstract

The strengthening of existing concrete structures using FRP composites had spread worldwide due to the advantages offered by these composites in comparison with other traditional materials. Basalt fiber reinforced polymer (BFRP) is a newly developed material in this field that is expected to compete strongly among other types of FRP composites. This research aimed at studying the flexural behavior of RC columns strengthened with different techniques using BFRP bars to assess their efficiency for strengthening RC columns in order to be introduced as an alternative to other types of FRP bars. Moreover, this study investigates a new type of strengthening technique named the "hybrid" technique, which is expected to offer lots of advantages owing to combining two well-known techniques, FRP jacketing and NSM techniques.

Basalt fibers are inorganic fibers, similar to glass fibers, that are created by melting basalt rocks. The manufacturing process of basalt fibers consumes less energy and does not need any other additives in the single production process, consequently, leading to a low cost of fibers. The initial studies showed that the basalt fibers have high tensile strength and modulus, better chemical resistance, extended operating temperature range, and are considered to be more eco-friendly when compared to E-glass. Furthermore, basalt-FRP has been proven to have advantages in attaining the goal of improving the safety and reliability of structural systems when compared to traditional glass FRP composites. These advantages make basalt fibers a promising alternative to glass fibers as a reinforcing and strengthening material.

This study consists of two phases, phase I was aimed at studying the mechanical properties of the basalt FRP bars. In this phase, several tests were conducted on the FRP bars to investigate their mechanical properties to be used later in phase II. Phase II was aimed at investigating the structural performance of RC columns strengthened with different techniques using BFRP bars. The variables considered in this phase are the strengthening effect (unstrengthened and strengthened), the type of the FRP bars (BFRP and GFRP), the strengthening technique (NSM and hybrid), and the diameter of the used FRP bars (10 mm and 12 mm). The test results are discussed and analyzed in terms of cracking, yielding, and ultimate behavior, in addition to the crack pattern and failure modes.

The test results showed the efficiency of strengthening RC columns with different techniques using BFRP bars in enhancing the overall flexural behavior. Moreover, the test results demonstrated the significance of using BFRP bars compared to the more traditional GFRP bars for strengthening RC columns. Using the NSM technique in strengthening RC columns can increase improve the ultimate load capacity and the ductility of the columns by 30% and 169%, respectively. Using the hybrid technique can significantly enhance the ultimate load capacity and the ductility of the columns by 95% and 241%, respectively.

Keywords: Flexural Strengthening of RC Columns; NSM; Basalt Fiber Reinforced Polymer (BFRP); Glass Fiber Reinforced Polymer (GFRP); FRP Jacket.

ACKNOWLEDGEMENT

First of all, I want to express my profound gratitude to ALLAH, for giving me the patience and the effort to complete this work.

It was a great honor to work under the supervision of Prof. Yehia Abdel-Zaher, Professor of Properties and Testing of Materials, Structural Engineering Department, Faculty of Engineering, Ain Shams University.

Special thanks to my supervisor; Dr. Ibrahim Abdel-Latif for his help and kind cooperation. I am really grateful for having the opportunity to work under his supervision.

I would like to express my deepest appreciation to Dr. Fareed Elgabbas for his valuable assistance, guidance, patience, and endless support throughout this research. I genuinely appreciate his patience and continuous support. I would like to thank him for his concentrated effort to finalize our work in a tight time frame and also to thank him for the technical knowledge he gave to me.

The experimental work was carried out at the Properties and Testing of Materials Laboratory of the Structural Engineering Department of Ain-Shams University. The help of the laboratory staff in developing this work is greatly appreciated.

I will always be indebted to my parents and my sister for their loving support and encouragement and for making me believe in my dreams and for supporting me to achieve them.

Researcher Data

Name	:	Mohamed Mostafa Abdel-Hamid Ramadan
Date of birth	:	15 September 1993
Place of birth	:	Cairo, Egypt
Last academic degree	:	Bachelor of Science in Civil Engineering
Field of specialization	:	Structural Engineering
University issued the degree	:	Ain Shams University
Date of issued degree	:	July 2016
Current job	:	Teaching Assistant, Structural Department, Faculty of Engineering, Ain Shams University

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