



شبكة المعلومات الجامعية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ





شبكة المعلومات الجامعية



شبكة المعلومات الجامعية

التوثيق الالكتروني والميكرو فيلم

# جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

## قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها  
على هذه الأفلام قد أعدت دون أية تغيرات



## يجب أن

تحفظ هذه الأفلام بعيداً عن الغبار

في درجة حرارة من 15 – 20 مئوية ورطوبة نسبية من 20-40 %

To be kept away from dust in dry cool place of  
15 – 25c and relative humidity 20-40 %



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# بعض الوثائق الأصلية تالفة



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بالرسالة صفحات

لم ترد بالأصل

**B1. YEA**

TANTA UNIVERSITY  
FACULTY OF ENGINEERING  
STRUCTURAL ENGINEERING DEPARTMENT

# **BEHAVIOR OF REINFORCED CONCRETE COLUMNS CONFINED BY FRP UNDER ECCENTRIC LOADS**

## **A THESIS**

Submitted to the Faculty of Engineering at Tanta University  
in Partial Fulfillment of the Requirements for the Degree of  
**Doctor of Philosophy**  
In  
**Civil Engineering "Structural Engineering"**

By

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**June, 2002**

**TANTA UNIVERSITY  
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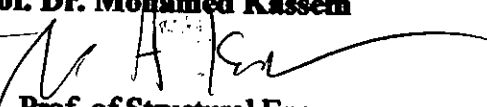
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**June, 2002**

**To My Father and Mother**

**To Whom I Own My Whole Life**

**To My Wife Rania and My Child Ahamed**

**To Whom I Live**

**To My Dear Prof. Dr. Kamal Nassif Ghali**



## APPROVAL SHEET

# BEHAVIOR OF REINFORCED CONCRETE COLUMNS CONFINED BY FRP UNDER ECCENTRIC LOADS

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## **STATEMENT**

This dissertation is submitted to TANTA UNIVERSITY for the degree of DOCTOR OF PHILOSOPHY in Civil Engineering "Structural Engineering".

The work included in this thesis was carried out by the author in the Department of Civil Engineering from June 1998 to June 2002 .

No part of this thesis has been submitted for a degree of a qualification at any University or Institution.

Signature:

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## ABSTRACT

FRP-confined concrete columns benefit from a confining effect due to restraint of the lateral expansion. This effect increases the strength and the ductility of the concrete confined by FRP shell for case of centric load, as given by many researchers. However, more research work is necessary in order to investigate experimentally the behavior of R.C. columns confined by FRP under eccentric loads, as it seems that axially loaded columns do not exist in practice and that is why eccentrically loaded columns may be more representative.

This thesis deals with the effect of load eccentricity on the ultimate load and ductility of confined columns with different height to depth ratio. Thirty R.C columns were tested and their results were analyzed. An analytical model is proposed for analysis of columns subjected to eccentric loads, also empirical equation based on experimental results is proposed, which can be used to determine the ultimate load of FRP-confined concrete columns under eccentric loads taking into account load eccentricity as well as height to depth ratio. Note that, we can not use any of the models given by many researchers which have been proved for case of centric loaded columns, as all these models based on a constant vertical strain of concrete along the column depth, while, in case of eccentric loading the vertical stress of concrete is no longer constant.

The proposed method of analysis is verified by comparing the prediction to experimental data published by different researches, as well as the present experimental work. Based on the finding, design guidelines are suggested.

Based on the proposed model, a computer program was designed specially to suite the unique response of FRP-confined concrete circular sections. In the same program we combine the design recommendations with the proposed design expressions to introduce a design program can be used to design FRP-confined short columns and piles, also an example for the proposed design procedure is given. A list of computer program is given in appendix "A".

## TABLE OF CONTENTS

Acknowledgement.....	I
Abstract.....	II
Table of Contents.....	V
List of Tables .....	XII
List of Figures.....	XIV
List of Symbols .....	XVIII
<b>CHAPTER (1) : INTRODUCTION .....</b>	<b>1</b>
1.1 General .....	1
1.2 Objectives.....	1
1.3 Scope and Contents .....	2
<b>CHAPTER (2) : LITERATURE SURVEY.....</b>	<b>5</b>
2.1 General .....	5
2.2 Behavior of Confined Concrete .....	5
2.2.1 Mechanism of Confinement in Concrete Contained by Cylindrical Shell... 6	6
2.2.1.1 Solid cylinder under axial pressure .....	6
2.2.1.2 Solid cylinder under radial pressure .....	7
2.2.1.3 Thin shell under radial pressure .....	7
2.2.2 Confinement using steel jackets-the active confinement .....	8
2.2.3 Confinement using FRP-jacket-the passive confinement.....	9
2.3 Effect of Slenderness on Confinement Efficiency .....	9

2.4 Effect of Bond Between FRP and Concrete on Confinement Efficiency .....	10
2.5 Effect of Geometry and Configuration of Cross Sections on Confinement ....	11
Efficiency.	
2.6 Comparison of FRP-Confined Concrete and Steel-Confined Concrete .....	12
2.7 Definition of Axially Loaded Members According to Some International Codes...	13
2.8 Capacity of Axially Loaded FRP-Confined Concrete Members .....	13
2.9 Physical and Mechanical Properties of Some Commercially Available Externally Bonded FRP Systems.....	14
2.9.1 Commercially available externally bonded FRP systems.....	14
2.9.1.1 Wet lay-up system.....	14
2.9.1.2 Pre-preg systems.....	15
2.9.1.3 Pre-cured systems.....	15
2.9.2 Physical properties of FRP .....	16
2.9.2.1 Density.....	16
2.9.2.2 Coefficient of thermal expansion.....	16
2.9.2.3 Effect of high temperatures.....	16
2.9.3 Mechanical properties and behavior of FRP.....	17
2.9.3.1 Tensile behavior.....	17
2.9.3.2 Compressive behavior.....	19
2.9.4 Time-dependent behavior of FRP .....	20
2.9.4.1 Creep rupture.....	20
2.9.4.2 Fatigue.....	20
2.9.5 Durability.....	22
2.9.6 FRP system qualification.....	22

## **CHAPTER (3) : BEHAVIOR AND MODELING OF CONFINED CONCRETE .33**

3.1 General .....	33
3.2 Triaxial Behavior of Concrete.....	33
3.3 Octahedral Theories.....	34
3.3.1 Definition.....	34
3.3.2 Octahedral stress-strain relations.....	35
3.4 Models Based on Octahedral Theories .....	38
3.4.1 Grestle's Model [17].....	38
3.4.2 Kotsovos and Newman [24].....	40
3.4.3 Cedolin's Model [9].....	42
3.4.4 Ahmed and Shah [3].....	45
3.4.5 Elwi and Murray [12].....	48
3.5 FRP-Confined Concrete Models Based on Octahedral Theories .....	54
3.5.1 Becque and Rizkalla Model [22].....	54
3.6 FRP-Confined Concrete Models Based on Energy Balanced Method .....	57
3.6.1 Parent and Labossiere [37].....	57
3.7 FRP-Confined Concrete Models Based on Mander's Model .....	61
2.3.3 Spoelstra and Monti [41] .....	61
3.8 Semi-empirical FRP-Confined Concrete Models .....	64
3.8.1 Razvi and Satacioglu [44] .....	64
3.9 FRP-Confined Concrete Empirical Models .....	66
3.9.1 Samaan et al Model [43] .....	66
2.3.4 Mirmiran and Shahawy model [32].....	70
3.10 Summary .....	73

## **CHAPTER (4) : EXPERIMENTAL WORK .....79**

4.1 General .....	79
4.2 Experimental Test Program.....	79
4.3 Characteristics of Material Used.....	81
4.4 Material and Fabrication .....	82