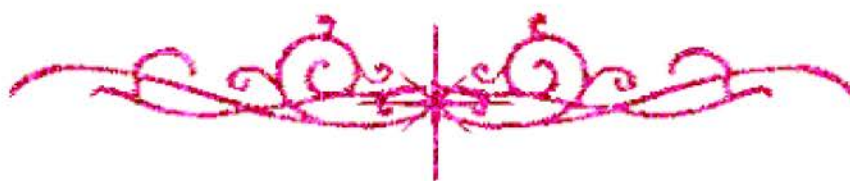


سامية محمد مصطفى



شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم



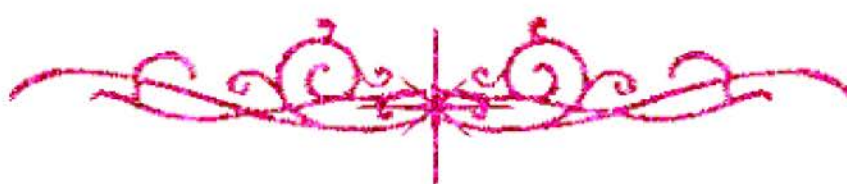
سامية محمد مصطفى



شبكة المعلومات الجامعية



شبكة المعلومات الجامعية التوثيق الالكتروني والميكروفيلم



سامية محمد مصطفى



شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

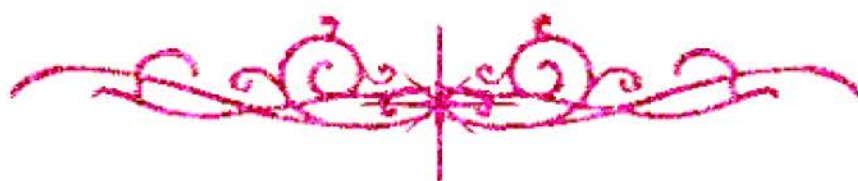
قسم

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



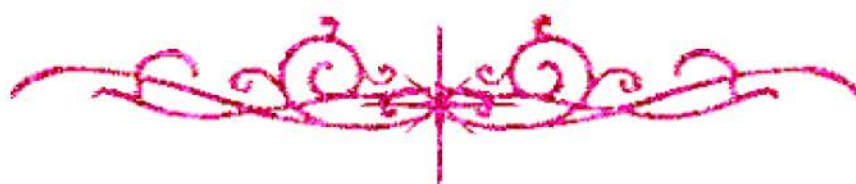
سامية محمد مصطفى



شبكة المعلومات الجامعية



بعض الوثائق الأصلية تالفة



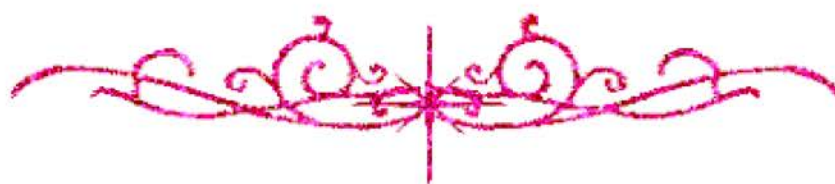
سامية محمد مصطفى

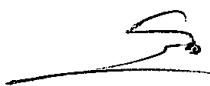


شبكة المعلومات الجامعية



بالرسالة صفحات لم ترد بالأصل





STRESS AND DEFLECTION ANALYSIS IN RIGID PAVEMENTS DUE TO MOVING AXLE LOADS

**A Thesis
Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Civil Engineering**

**by
Yasser Hassan Ahmed**

**B.Sc. of Civil Engineering
Cairo University
1989**

Supervised by

**Prof. Dr. Ahmed Atef Gadallah
Prof. of Highway and Airport Engineering
Public Works Department
Faculty of Engineering
Cairo University**

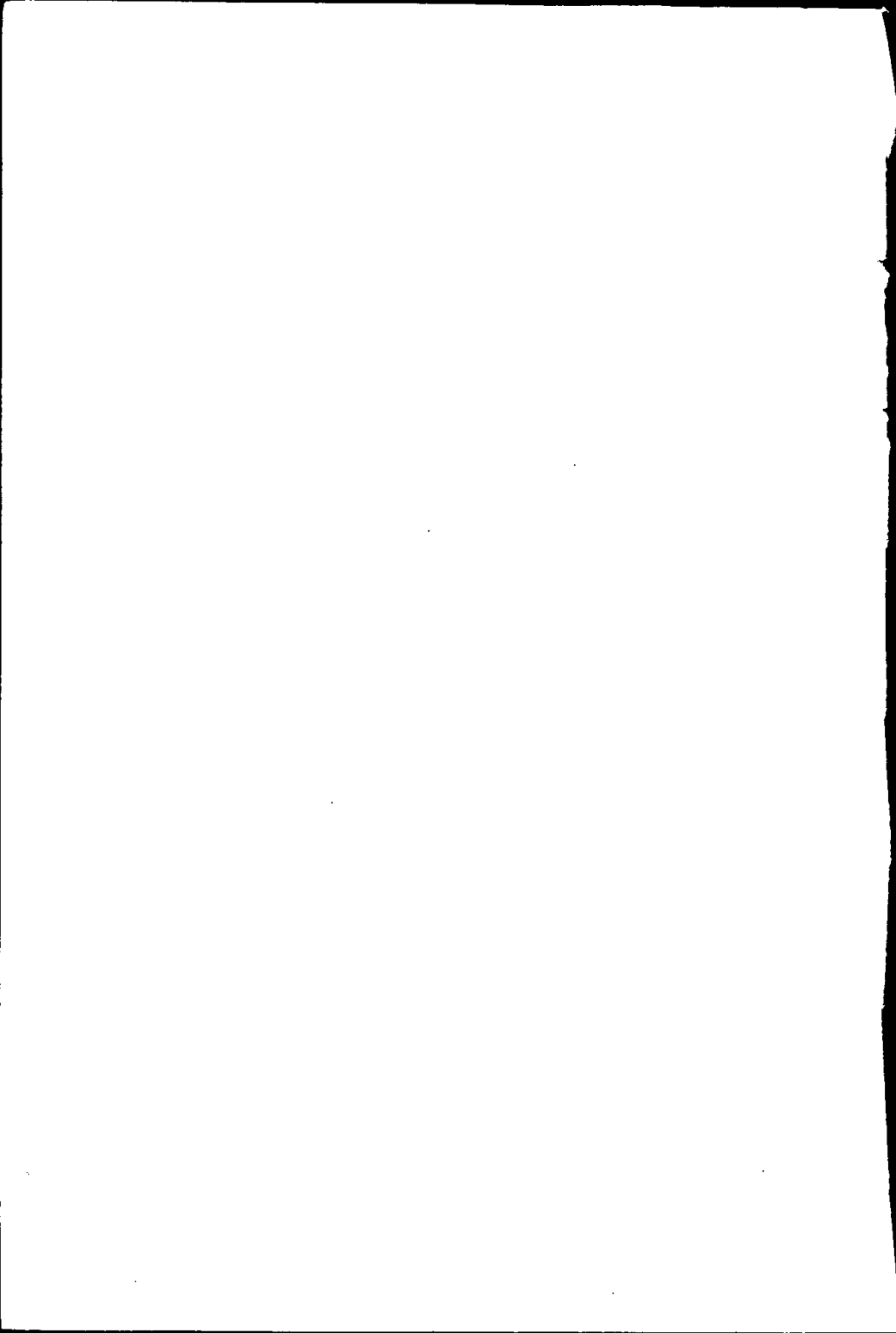
**Dr. Amr Wagieh Sadek
Assoc. Prof. of Structural Engineering
Structural Engineering Department
Faculty of Engineering
Cairo University**

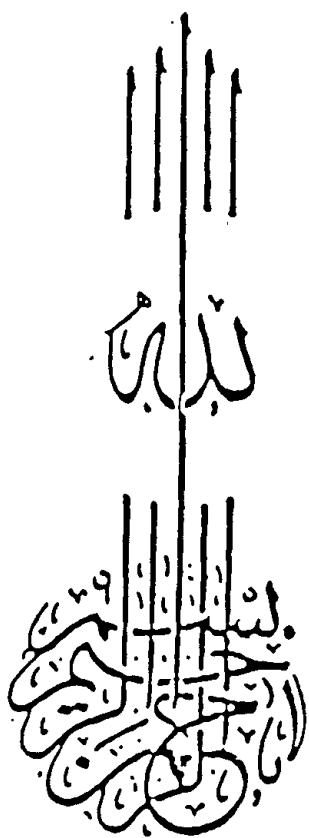
**Dr. Ragab Mousa Mohamed
Assistant Prof. of Highway and Traffic Engineering
Public Works Department
Faculty of Engineering
Cairo University**

**Cairo University
Faculty of Engineering
1993**

B

17-9.





وَقُلْ رَزَوْنِي عِلْمًا

صدق اسد العظیم

ACKNOWLEDGEMENT

The author wishes to express his sincere gratitude and deep thanks to *Prof. Dr. Ahmed Atef Gsdallih* (Prof. of Highway and Airport Engineering, Cairo University) who supervised this thesis and offered the support for its preparation.

The author wishes also to express his deepest appreciation and gratitude to *Dr. Amr Wagieh Sadek* (Assoc. Prof. of Structural Engineering) Cairo University, and *Dr. Ragab Mousa Mohammed* (Assistant prof. of Highway and Traffic Engineering, Cairo University) for their precious advice and stimulating supervision and encouragement.

Appreciation is expressed to all the staff of the Public Works Department (Division of Highway, Airport, and Traffic Engineering), Cairo University, for their encouragement and useful suggestions throughout the study.

ABSTRACT

Since the beginning of this century, many procedures have been used in the analysis of rigid pavement subject to wheel loads and environmental effects. Among these methods is the finite element approach which has become the most commonly used. In this study, the Finite Element Method (FEM) was utilized to analyze rigid highway pavement subject to static and moving axle loads. This was done by developing two computer programs, one for static axle loads and the other for moving axles. In these programs, every possible effort was made to ensure the program efficiency in handling matrices and storage requirements. The model considers several parameters that represent pavement and loading properties including axle load, axle speed, load position, tire pressure, slab dimensions, modulus of subgrade reaction, and condition of load transfer at transversal joints. Slabs are idealized into rectangular plate elements connected at their corners and subject to bending stresses. The Winkler model was used to simulate the subgrade as individual elastic and massless springs.

By assigning values to the named parameters, the proper model can be used to determine the resulting deflections and stresses throughout the slab area. The model then searches the results for maximum deflection and stress that correspond to assigned pavement and load properties. Over 200 computer runs were made to provide enough results to help investigate the effect of individual parameters on the trends as well as the absolute values of the maximum deflection and stress. The

analysis of results showed that the maximum stress and deflection occur at the transversal joint when the axle load is located near to that joint. This may call for special attention to the design and load handling at slab transversal joints. Further analysis of the results indicated that maximum deflection depends on the axle load, modulus of subgrade reaction, and load transfer condition at the transversal joint, while maximum stress depends on the axle load and slab thickness. The dynamic effect on deflection was found to be higher for pavements with high relative stiffness and deflection in this case may reach 140% of its static value. Interestingly, the axle speed had no significant effect on the maximum stress.

TABLE OF CONTENTS

	<u>Page</u>
Acknowledgment	i
Abstract	ii
Table of Contents	iv
List of Tables	viii
List of Figures	ix
 CHAPTER 1: INTRODUCTION	 1
 CHAPTER 2: OBJECTIVES AND SCOPE OF WORK	 3
2.1 The Problem Statement	3
2.2 Objectives of the Study	3
2.3 Scope of Work	4
 CHAPTER 3: LITERATURE REVIEW	 6
3.1 Background	6
3.2 Stresses in Rigid Pavement	6
3.2.1 Warping Stresses	6
3.2.2 Frictional Stresses	9
3.2.3 Load Stresses	10
3.3 Design Methods of Rigid Pavement	22
3.3.1 Present PCA Design Method	23
3.3.2 New PCA Design Method	32
3.3.3 The 1986-AASHTO Design Method	44
 CHAPTER 4: STATIC ANALYSIS OF RIGID PAVEMENT USING THE FINITE ELEMENT METHOD	 49

4.1	Introduction	49
4.2	Background to the FEM	49
4.3	Analysis of Rigid Pavement Slabs Using the FEM	51
4.3.1	The Element Stiffness Matrix	56
4.3.2	Assembly of the Overall Stiffness Matrix [K]	62
4.3.3	Shear Transfer Models	63
4.3.4	Modeling of Subgrade Soil	66
4.3.5	Load Vector	68
4.3.6	Nodal Displacement Vector	69
4.3.7	Final Stresses	69
4.4	Program Features	75
4.4.1	Loading	76
4.4.2	Mesh Generation	82
4.4.3	Check of Soil Separation	83
4.4.4	Final Stresses	85
4.4.5	Pavement Properties	85
4.5	Program Verification	86

CHAPTER 5: DYNAMIC ANALYSIS OF RIGID PAVEMENT SUBJECT TO MOVING LOADS

		90
5.1	Introduction	90
5.2	Equation of Motion	90
5.3	Dynamic Analysis of Rigid Pavement Slabs Using the FEM	91
5.3.1	The Mass Matrix	92
5.3.2	The Damping Matrix	94
5.3.3	Reduction of Dynamic Matrices	98
5.3.4	Solution of the Equation of Motion	100