١٠٢٨٦/٢

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING

ELASTIC BEHAVIOUR OF THE CORE STRUCTURE SYSTEM UNDER THE EFFECT OF EQUIVALENT STATIC WIND LOAD.

BY
MOHAMMAD A.MONEM A.MEGEED
B.Sc. CIVIL ENGINEERING
AIN SHAMS UNIVERSITY , 1984

624.172
M.A

3041

THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS OF THE DEGREE OF
MASTER OF SCIENCE
IN
STRUCTURAL ENGINEERING

SUPERVISORS

Dr. M. ZIDAN , Eng.
ASSOCIATE PROF. OF CIVIL
ENGINERRING
STRUCTURAL ENGINEERING DEPT.
FACULTY OF ENGINEERING
AIN SHAMS UNIVERSITY

Dr.H. EL-KHORAIBIE , Eng.
ASSISTANT PROF OF CIVIL
ENGINEERING
STRUCTURAL ENGINEERING DEPT.
FACULTY OF ENGINEERING
EL-AZHAR UNIVERSITY

Central Library - Ain Shams University

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING

ANALYSIS OF THE ELASTIC BEHAVIOUR OF THE CORE STRUCTURE UNDER THE EFFECT OF EQUIVALENT STATIC WIND LOAD.

BY
MOHAMMAD A.MONEM A.MOGEED
B.Sc. CIVIL ENGINEERING
AIN SHAMS UNIVERSITY 1984

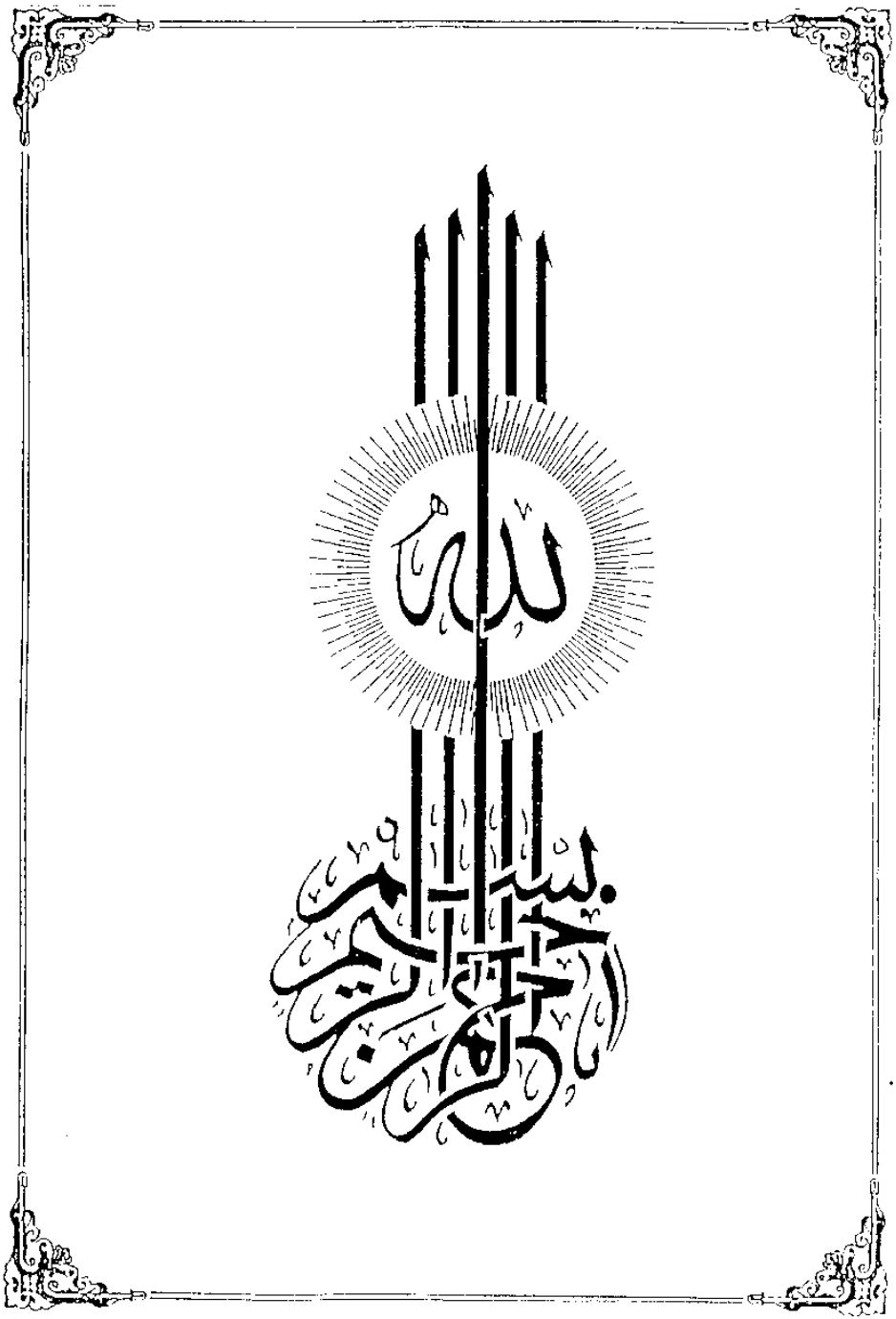
THESIS
SUBMITTED FOR THE PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN
STRUCTURAL ENGINEERING

SUPERVISORS

Dr. M. ZIDAN , Eng.
ASSOCIATE PROF OF CIVIL ENGINEERING
STRUCTURAL ENGINEERING DEPT.
FACULTY OF ENGINEERING
AIN SHAMS UNIVERSITY

Dr. F. EL-KHORAIBIE , Eng.
ASSISTANT PROF OF CIVIL ENGINEERING
STRUCTURAL ENGINEERING DEPT
FACULTY OF ENGINEERING
EL-AZHAR UNIVERSITY

Central Library - Ain Shams University



Central Library - Ain Shams University

Statement

This dissertation is submitted to Ain Shams university for the degree of Master of science in structural engineering.

The work included in this thesis was carried out by the author in the department of structural engineering , Ain Shams university , from October 1985 to September 1989.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Date :

Signature :

Name :

Central Library - Ain Shams University

Examiners committee

Name , title & affiliation — Signature

1- **Hassan Hosny**

Professor

El-Mattaria , Faculty of Engineering

Helwain University

2- **Mahmoud Galal Hashish**

Professor

Ain Shams University

Faculty of Engineering

3- **M. Zidan**

Assoc. Professor

Ain Shams University

Faculty of Engineering.

Date :

Central Library - Ain Shams University

Acknowledgements

The author wishes to express his devout appreciation and gratitude to Assoc. Prof. **M. Zidan** of the Structural Engineering Department , Faculty of Engineering , Ain Shams University and to Assist. Prof. **H. El-Khoraibie** of the Structural Department , Faculty of Engineering , El-Azhar University for their indispensable assistance and contributions during the course of development of the thesis.

The author further wishes to acknowledge the fruitful co-operation of the Department of Systems of the Engineering Consultants Group. The author also extends his appreciation to Eng. **Ashraf H. Allouba** , president of the Engineering Consultants Group for the use of the computer facilities available at the company.

The author wishes to thank Eng. **Medhat Zaky** and Eng. **Sherif Abdel-Nabi** for their great co-operation in the computer runs stage during this thesis.

Central Library - Ain Shams University

Ain Shams University

Faculty of Engineering

Dept of : Structural Engineering

Abstract of the M.Sc. Thesis submitted by : **Mohammad Abdel-Monem Abdel-Megeed**

Title of Thesis " **Elastic behaviour of the core structure under the effect of equivalent static wind load** ".

Supervisors: **(1) Assoc. Prof. M. Zidan**

(2) Assit. Prof. H. El-Khoraibie

Registration Date: Examination Date:

Abstract: A proposed analogy using the space frame method is adopted for the analysis of the core structure. The proposed analogy provides an acceptable alternative to the finite element technique. The concept of the idealized space frame method and its components is developed. The effect of shear deformation factor is considered in the analysis. Check of the accuracy of results is investigated when modeling the lintels either by a frame element or by equivalent continuum lamena in the shell element model. A modified element is developed to represent the core lintels. A versatile parametric study is performed to show the relation between the lintel stiffness and , both stress and displacement. An efficient tool to decrease

Central Library - Ain Shams University

the core drift by using the bracing elements is explained. A comparison between the flexural cantilever method and the space frame method is made to put limits for the safe use of the first method in the design of core structures.

Key words: Space frame , line element , shell element , core structure , lintel stiffness , flexural method.

Central Library - Ain Shams University

Table of contents

	Page
Statement	I
Examiners committee	II
Acknowledgements	III
Abstract	IV
Table of contents	VI
List of tables	X
List of figures	XII
Chapter "1" : Introduction	1
1.1 General	1
1.2 Structural systems for reinforced ..... concrete buildings	2
1.3 Structural loads	6
1.4 High rise building structural forms	7
1.5 Assumptions for analysis	8
1.6 Classification of the problem.....	12
1.7 Objectives	15
1.8 Scope of work	15
Chapter "2" : Literature review of core analysis	17
2.1 Core supported structures	17
2.1.1 Flexural behaviour of core wall	17
2.1.2 Torsion of core	19

Central Library - Ain Shams University

Page

2.2 Methods used for torsinal analysis of .. 19
core .....

2.2.1 The folded plate approach 19

2.2.2 Vlasov's theory for thin-walled 21
beams .....

2.2.3 Methods based on the continuum .. 22
approach in conjunction with ....
Vlasov's theory .....

2.2.4 Stiffness method techniques 24

2.3 Comparison between the stiffness and ... 50
continuum methods of analysis .....

Chapter "3" : **Analysis of non-planar shear-wall ..** 53
asswmblies (cores) by space .....
frame method .....

3.1 Introduction 53

3.2 Description of the method 53

3.2.1 Mathematical model 55

3.2.2 The stiffness matrix [S] of the 59
space frame .....

3.2.3 Conversion of the space frame ... 63
results into wall stress .....

3.2.4 Advantages of space frame 64
method .....

3.3 Case study 66

3.3.1 Methods used in analysis 67

Central Library - Ain Shams University

Page

3.3.2 Space frame model 69

3.3.3 Finite element model 69

3.3.4 Results 72

3.4 Modeling of core lintels in the shell element method 111

3.5 Case study 112

3.5.1 Mathematical models 112

3.5.2 Results 113

3.6 Modification of lintel modeling 121

3.7 Conclusions 125

Chapter "4" : **Applications of the space frame method to the analysis of core structures provided with stiffened elements** 129

4.1 Introduction 129

4.2 Lintel stiffness effect 129

4.2.1 Case study 130

4.2.2 Mathematical model 130

4.2.3 Results 130

4.3 Top hat 153

4.3.1 Case study for the top bracing . 156

4.3.2 Results 156

4.3.3 Case study for intermediate bracings at certain levels 162

4.3.4 Results 163

Central Library - Ain Shams University

Page

4.4 Conclusions 172

Chapter "5" : Comparison between flexural 174
cantilever method and space .....
frame method in the analysis of ....
core structure .....

5.1 Introduction 174

5.2 Case study (1) 175

5.2.1 Mathematical models 176

5.2.2 Results and comments 176

5.3 Case study (2) 186

5.3.1 Mathematical models 187

5.3.2 Results and comments 187

5.4 Case study (3) 197

5.4.1 Mathematical models 197

5.4.2 Results and comments 198

5.5 Conclusions 207

Chapter "6" : Summary & conclusions and 209
recommendations .....

6.1 Summary 209

6.2 Conclusions 211

6.3 Recommendations 216

6.4 Suggested Future development in the..... 218
analysis of core structure.....

Appendix (I) Shell element 219

Appendix (II) Computer programmes 230

References 232

Central Library - Ain Shams University

List of tables

Table		Page
(1.1)	Number of storeys	4
(3.1)	Comparison of rotations under torsional load ..	87
(3.2)	Comparison of lintel shears in core with ..... 12in x 20in lintels	88
(3.3)	Comparison of lintel shears in core with ..... 16in x 36in lintels	89
(3.4)	Comparison of displacement under lateral load . in Y-direction	94
(3.5)	Comparison of displacement under lateral load . in X-direction	101
(3.6)	Comparison of rotation under lateral load ..... in X-direction	108
(3.7)	Comparison of the top rotation	125
(4.1)	Comparison of rotation of the different ..... models under torsional load	137
(4.2)	Comparison between top X-displacements in the . load direction	142
(4.3)	Comparison between the top rotation	142
(4.4)	Comparison between the top rotation	159
(4.5)	Comparison between the top displacements (in .. the load direction)	161
(4.6)	Comparison between the top rotation	161
(4.7)	Comparison of lintel shears	162
(4.8)	Comparison between the top rotation.....	163

Central Library - Ain Shams University

Table		Page
(4.9)	Comparison of lintel shears under the effect of torsional load	168
(4.10)	Comparison between the top displacement (in the load direction)	170
(4.11)	Comparison between the top rotations	171
(4.12)	Comparison of lintel shears under the effect of lateral load acting parallel to lintels	172

Central Library - Ain Shams University

List of figures

Figure		Page
(1.1)	Rigid frame system (plan)	3
(1.2)	Shear wall system (plan)	3
(1.3)	Combined frame and shear wall system (plan)	3
(1.4)	Framed tube system (plan)	3
(1.5)	Tube in tube system (plan)	5
(1.6)	Bundled tube system (plan)	5
(1.7)	Forms of shear wall structure	8
(1.8)	Different plan configuration of shear and core walls	10
(1.9)	Plans classification	14
(2.1)	Behaviour of core walls in bending	18
(2.2)	Core element	26
(2.3)	Perforated wall model	29
(2.4)	Analogous frame module	32
(2.5)	Analogous frame module subjected to shear	32
(2.6)	Analogous frame module subjected to bending	32
(2.7)	Analogous frame module subjected to axial force	32
(2.8)	Actions in frame module	36
(2.9)	column analogy model	36
(2.10)	Braced wide-column analogy	36
(2.11)	Braced wide-column module	39
(2.12)	Braced wide-column module in bending	39
(2.13)	Braced wide-column module in shear	39
(2.14)	Braced wide-column module in extension	39

Central Library - Ain Shams University