



شبكة المعلومات الجامعية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ





شبكة المعلومات الجامعية



شبكة المعلومات الجامعية

التوثيق الالكتروني والميكرو فيلم

جامعة عين شمس

التوثيق الالكتروني والميكرو فيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد اعدت 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 %



شبكة المعلومات الجامعية



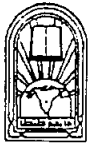
بعض الوثائق الأصلية تالفة



شبكة المعلومات الجامعية



بالرسالة صفحات
لم ترد بالأصل



Tanta University
Faculty of Engineering

EARTHQUAKE ANALYSIS OF R.C. CHIMNEYS ON RIGID AND FLEXIBLE SOIL

A Thesis Submitted for the Partial Fulfillment
of the Requirements for
the Degree of

MASTER OF SCIENCE
In
STRUCTURAL ENGINEERING

By

ISLAM MOHAMED HELMI EZZ EL-ARAB

Demonstrator, Faculty of Engineering, Tanta University
B.Sc. structural Engineering Dept., Tanta University, 1998

Under the Supervision of

M. A. Kassem
Prof. Dr. MOHAMED A. KASSEM

Professor of Structural Analysis
Faculty of Engineering
Tanta University

Assoc. Prof. Dr. SAHER R. EL-KHORIBY

Assoc. Prof. Structural Engineering Department
Faculty of Engineering
Tanta University *Sa*

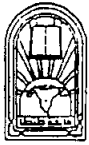
Dr. FAHMY ABD EL-FTTAH ZAHER

Assi. Pro. Structural Engineering Department
Faculty of Engineering
Tanta University *Fahmy*

B

1-A-C

2002



Tanta University
Faculty of Engineering

EARTHQUAKE ANALYSIS OF R.C. CHIMNEYS ON RIGID AND FLEXIBLE SOIL

A Thesis Submitted for the Partial Fulfillment
of the Requirements for
the Degree of

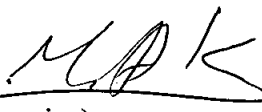
MASTER OF SCIENCE
In
STRUCTURAL ENGINEERING

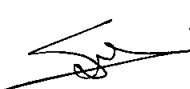
By

ISLAM MOHAMED HELMI EZZ EL-ARAB

Demonstrator, Faculty of Engineering, Tanta University
B.Sc. Structural Engineering, Tanta University, 1998

Approved by the Advising and Examining Committee:

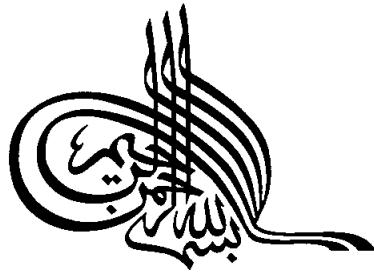
Prof. Dr. **MOHAMED AHMED KASSEM**, Advisor (Tanta University) 

Assoc. Prof. Dr. **SAHER RAAFT EL-KHORIBY**, Advisor (Tanta University) 

Dr. **FAHMY ABD EL-FTTAH ZAHER**, Advisor (Tanta University) 

Prof. Dr. **SALAH EL-DIN EL-METWALLY**, Examiner (Mansoura University) 

Prof. Dr. **EL-SAID AMIEN MSHALY**, Examiner (Alexandria University) 



" و ما أوتيتم من العلم إلا قليلا "

صدق الله العظيم

To my father and mother

ACKNOWLEDGMENTS

First and foremost, praise and thanks be to be Almighty **ALLAH**, the most Gracious, the most merciful and peace is upon his prophet.

Acknowledgment is due to Faculty of Engineering, Tanta University and to my advisors Prof. Dr. **Mohamed A. Kassem** and Dr. **Fahmy A. zaher**. Their invaluable guidance, support and encouragement through all stages of this study are highly appreciated. Special thanks with deep respect are to Asso. Prof. Dr. **Saher R. EL-Khoriby**, who not only proved to be the source of inspiration to me but also an ever flowing stream of encouragement and able guidance.

I would like also to thank Prof. Dr. **salah EL-Metwally** for his valuable suggestions and advice during this study.

Also, greet thanks for the cooperation and help offered by The Structural Engineering Department Staff have, who helped me to complete the research in time.

I would like also to express my deep thanks to my father and my mother for their support through the course of this research.

Lastly but not last thanks are to those who directly or indirectly participated in completing this thesis.

ABSTRACT

Because of the tallness and slenderness of chimney structure, it is strongly affected by earthquakes. In analyzing of R.C. chimneys subjected to such type of loading, the ACI, I.S., and other specifications provide two procedures for obtaining the equivalent effect of earthquake on structures such as chimneys. One of these, is the equivalent static lateral force method, which is based on the fundamental period of vibration. Other, is the dynamic response spectrum method, which is mainly dependent on the dynamic characteristics of the chimney.

To analyze any chimney with any dimensions by the response spectrum method, it is required first to obtain the chimney model characteristics, which in turn requires constructing mathematical model and performing computer analysis for each chimney. As this procedure consumes time and effort, this study aims to search about simple and exact formulae for quick calculation of chimney as function of its geometrical and material properties. In this study the obtained simple formulae predicting preciously the chimney base moment, base shear, and top lateral displacement due to EL-Centro-1940 Earthquake ground motion.

On other hand, the effect of soil-structure interaction has been considered in this study, as well as linear and nonlinear analysis is performed to have actual and optimum stress due to the effect of major earthquakes.

Also, a parametric study has been presented to show the influence of chimney these parameters on the dynamic response of R.C. chimney on rigid and flexible soil media.

Finally, the simple equivalent estimates has been obtained for the effect of soil flexibility on natural frequencies, straining actions at the base, and top lateral displacement for any chimney. Which, save time and effort with highly accurate results.

List of Contents

Subject	Page
Acknowledgment	i
Abstract	ii
List of Contents	vi
Notations	vii
List of Tables	viii
List of Figures	

Chapter (1): Introduction

1.1 Introduction and Definition of the Problem	1
1.2 Objectives of Present Study	2
1.3 Thesis Organization	3

Chapter (2): Review of Literature on R.C. Chimneys and Soil-Structure Interaction

2.1 Introduction	5
2.2 Literature Review For the Dynamic Analysis of R.C. Chimneys on Rigid Media	5
2.3 Literature Review For the Soil-Structure Interaction ...	7
2.3.1 Effect of Soil-Structure Interaction	7
2.3.2 Literature Review For the Soil Modeling	9
2.3.2.1 Finite Element Approach	11
2.3.2.2 Elastic half-Space Approach.....	11
2.3.2.3 Equivalent Static Spring Approach	12
2.4 Impedance Functions	13
2.4.1 Impedance Functions for Shallow Foundation	13
2.4.2 Impedance Functions for Deep Foundation	14
2.4.3 Frequency - Independent Dynamic Soil Impedance.....	14
2.4.4 Frequency - Dependent Dynamic Soil Impedance.....	16
2.5 Method of Analysis for Soil-Structure Interaction Problems .	18
2.5.1 Simplified Substructure Method	20
2.5.2 General Substructure Method	21
2.6 Historical Review	22
2.6.1 Types of Chimneys	22
2.6.2 Height	22
2.6.3 Number of Flues	23
2.6.4 Reinforced Concrete as a Construction Material..	24

2.6.5 Parts of a Chimney	24
2.6.5.1 Foundation	24
2.6.5.2 Outer Column	25
2.6.5.3 Liners	25
2.6.6 R.C. Chimneys Configuration	25
2.6.7 Loads	26
2.6.7.1 Earthquake Loading	26
2.6.7.2 Seismic Excitation	26
2.7 Concepts of Dynamic Analysis of Chimneys	27

Chapter (3): System Idealization and Equations of Motion

3.1 Introduction	32
3.2 Idealization	32
3.3 Assumption and Notations	33
3.4 Structure Subsystem Idealization	35
3.4.1 Beam Element Modeling	35
3.4.1.1 Stiffness Matrix	35
3.4.1.2 Mass Matrix	36
3.4.2 Solid Element Modeling	38
3.4.2.1 Stiffness Matrix	38
3.4.2.2 Mass Matrix	39
3.5 Soil Subsystem Idealization	40
3.5.1 Frequency-Independent Soil Impedance	40
3.6 Equation of Motion	41
3.6.1 Equations of Motion on Rigid Foundation	41
3.6.2 Equation of Motion on Flexible Foundation	43
3.7 Linear and Nonlinear Finite Element Scheme	45
3.8 Structural Nonlinearities	46
3.8.1 Geometrical Nonlinearities	46
3.8.2 Material Nonlinearities	46
3.9 Material Models	47
3.9.1 Drucker - prager Elastic - Perfectly Plastic Model	48
3.10 Analysis Procedure	48
3.10.1 Incremental Force Application	49
3.10.2 Newton-Raphson Iteration	49
3.10.3 Displacement Convergence	50
3.11 Computer Analysis	51
3.11.1 Modeling Technique and Input File For Program-(I)	51
3.11.2 Computer Output	61
3.11.3 Computer Results	71

Chapter (4): Free Vibration Analysis of R.C. Chimneys

4.1 Introduction	73
4.2 Mathematical Model	74
4.3 The Comparative Study	80
4.4 Parametric Study on Rigid Soil	84
4.4.1 Effect of Chimney's Height (H)	84
4.4.2 Effect of Top to Bottom Mean Diameters Ratio (D_1/D_2)	87
4.4.3 Effect of Top to Bottom Mean Thickness Ratio (t_1/t_2)	90
4.5 Effect of Soil Flexibility on Modal Characteristics	93
4.5.1 Natural Periods for Flexible Base Chimneys	96
4.5.2 Flexible Base Periods By Simple Formulae	98
4.6 Parametric Study on Flexible Soil	101
4.6.1 Effect of Chimney's Height (H)	101
4.6.2 Effect of Top to Bottom Mean Diameters Ratio (D_1/D_2)	110
4.6.3 Effect of Top to Bottom Mean Thickness Ratio (t_1/t_2)	110

Chapter (5): Earthquake Ground Motion Analysis

5.1 Introduction	126
5.2 Type of Earthquake Excitation	126
5.3 Earthquake Analysis	127
5.4 Achieved formulae of Earthquake Ground Motion Analysis	132
5.4.1 Rigid Soil	132
5.4.2 Medium Soil	133
5.4.3 Weak Soil	134
5.5 Parametric Study on Rigid Soil	140
5.5.1 Effect of Chimney's Height(H)	140
5.5.2 Effect of Top to Bottom Mean Diameters Ratio (D_1/D_2)	143
5.5.3 Effect of Top to Bottom Mean Thickness Ratio (t_1/t_2)	143
5.6 Parametric Study on Flexible Soil	147
5.6.1 Effect of Chimney's Height (H)	147
5.6.2 Effect of Top to Bottom Mean Diameters Ratio (D_1/D_2)	152
5.6.3 Effect of Top to Bottom Mean Thickness Ratio (t_1/t_2)	152

Chapter (6): Conclusions and Recommendations

6.1 Summary Conclusions	159
6.2 Recommendations	161
6.3 Scope of The Future Study	161
References	162
Appendix (A)	168
Appendix (B)	177
Arabic Summary	