



Cairo University

# Human Comfort Study of Medium Rise Reinforced Concrete Buildings under Wind Excitations

By

Sharehan Harby Ali El Sherif

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
in Partial Fulfillment of the  
Requirements for the Degree of  
**MASTER OF SCIENCE**  
in  
Structural Engineering

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## Human Comfort Study of Medium Rise Reinforced Concrete Buildings under Wind Excitations

**Key Words:**

Human comfort; reinforced concrete building; wind load; wind induced vibration

**Summary:**

Wind induced motion in buildings may result in excessive vibrations that hinder the usage of them. Traditionally, wind loads are represented as static forces acting on the building with increased magnitudes relative to its height. Consideration of human comfort limits is not a common practice for regular designers. A parametric study is conducted to investigate the effect of different parameters on the human comfort limits of medium rise buildings. The parameters include the used structural system, number of floors, and floor height. Total of 92 models are examined using linear static and dynamic analyses to determine the acceleration and drift values under wind loading. Static analysis as well as dynamic (time history) analyses are employed in the performed parametric study.

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# Table of Contents

ACKNOWLEDGMENTS .....	5
TABLE OF CONTENTS.....	6
LIST OF TABLES .....	8
LIST OF FIGURES .....	9
ABSTRACT.....	XII
CHAPTER 1 : INTRODUCTION .....	1
1.1.    INTRODUCTION .....	1
1.2.    PROBLEM STATMENT.....	1
1.3.    SCOPE OF THE RESEARCH .....	1
1.4.    ORGANIZATION OF THE THESIS .....	2
CHAPTER 2 : LITERATURE REVIEW .....	3
2.1.    INTRODUCTION .....	3
2.2.    DYNAMIC NATURE OF WIND LOADING .....	3
2.3.    INFLUENCE OF HUMAN COMFORT .....	3
2.4.    EXPERIMENTAL STUDIES .....	4
2.5.    NUMERICAL STUDIES.....	4
2.6.    IMPORTANCE OF UNDERSTANDING WIND LOADING .....	5
2.7.    RECOMMENDATIONS IN DESIGN CODES .....	5
2.7.1.    Comfort Criteria .....	9
2.7.2.    Measures Of Human Comfort .....	11
CHAPTER 3 : METODOLOGY .....	15
3.1.    INTRODUCTION .....	15
3.2.    MODELING PROCEDURE .....	15
3.3.    DESCRIPTION OF THE MODELS.....	16
3.3.1.    Geometry .....	16
3.3.2.    Material .....	17
3.3.3.    Design of the models .....	18
3.3.4.    Loads .....	18
3.3.4.A.    Static Loads.....	18
3.3.4.B.    Dynamics Load .....	18
3.3.5.    Studied Parameters .....	19
3.3.6.    Determination of acceleration.....	22
3.3.7.    Results .....	23
3.4.    PROGRAMS USED.....	23
3.4.1.    Etabs 9 Program .....	23
3.4.2.    SAP2000 Program .....	23

<b>CHAPTER 4 : RESULTS .....</b>	<b>25</b>
<b>4.1.    STATIC ANALYSIS RESULTS.....</b>	<b>25</b>
4.1.1.    Effect of statical system.....	25
4.1.1.1.    Number of floors (15 floors) .....	25
4.1.1.2.    Number of floors (20 floors) .....	31
4.1.1.3.    Number of floors (25 floors) .....	36
4.1.2.    Effect of Number of floors .....	41
4.1.2.1.    Flat slab without drop system .....	41
4.1.2.2.    Flat slab with drop system.....	46
4.1.2.3.    Solid slab system.....	51
4.1.3.    Drift results .....	56
4.1.3.1.    Number of floors (15 floors) .....	56
4.1.3.2.    Number of floors (20 floors) .....	57
4.1.3.3.    Number of floors (25 floors) .....	58
<b>4.2.    COMPARISON BETWEEN STATIC AND DYNAMIC ANALYSES.....</b>	<b>59</b>
4.2.1.    Dynamic vs. Static Analyses .....	59
 <b>CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS .....</b>	 <b>68</b>
5.1.    SUMMARY .....	68
5.2.    CONCLUSIONS .....	69
5.3.    FUTURE RESEARCH WORK .....	69
<b>REFERENCES .....</b>	<b>70</b>

## List of Tables

<b>Table 2.1:</b> Explain of curves in Figure 2.1 (Henrietta V.C. Howarth-Michael J. Griffin).....	8
<b>Table 2.2:</b> Application of the limit curves in BS 6611 and ISO 6897 for horizontal motion events of more than 10 minutes duration (see Figure 2.1) (Henrietta V.C. Howarth-Michael J. Griffin).....	8
<b>Table 2.3:</b> Levels of human perception by Chang (1967).....	9
<b>Table 2.4:</b> Perception thresholds determined from motion simulator tests and full-scale studies by R.Bashor, T.Kijewski, A.Kareem.....	12
<b>Table 3.1:</b> Studied parameters.....	19
<b>Table 3.2:</b> Notation of Studied Models for the Static Analysis.....	21
<b>Table 3.3:</b> Notation of Studied Models for the Dynamic Analysis.....	22
<b>Table 4.1:</b> Dynamic models parameters.....	58
<b>Table 4.2:</b> Difference between static and dynamic displacement percentage .....	67



## List of Figures

<b>Figure 2.1:</b> limit curves for horizontal motion as given in BS 662 and ISO 6897(Henrietta V.C. Howarth-Michael J. Griffin).....	7
<b>Figure 2.2:</b> Tolerance thresholds proposed by Chang (1967).....	10
<b>Figure 2.3:</b> Perception threshold – RMS acceleration by Lawrence G. Griffis (1993).....	10
<b>Figure 2.4:</b> Perception threshold – Peak acceleration by Lawrence G. Griffis (1993).....	11
<b>Figure 3.1:</b> Prototype elevations of the model buildings.....	17
<b>Figure 3.2:</b> Location of the shear walls.....	17
<b>Figure 3.3:</b> Time history for wind record.....	19
<b>Figure 4.1:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for $t_{wall}=20cm$ .....	28
<b>Figure 4.2:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 15 floors for $t_{wall}=20cm$ .....	28
<b>Figure 4.3:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for $t_{wall}=30cm$ .....	28
<b>Figure 4.4:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 15 floors for $t_{wall}=30cm$ .....	28
<b>Figure 4.5:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for internal walls.....	29
<b>Figure 4.6:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 15 floors for internal walls.....	29
<b>Figure 4.7:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for external walls.....	29
<b>Figure 4.8:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 15 floors for external walls.....	29

<b>Figure 4.9:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for $t_{wall}=20cm$ .....	34
<b>Figure 4.10:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 15 floors for $t_{wall}=20cm$ .....	34
<b>Figure 4.11:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for $t_{wall}=30cm$ .....	34
<b>Figure 4.12:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 15 floors for $t_{wall}=30cm$ .....	34
<b>Figure 4.13:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for internal walls.....	35
<b>Figure 4.14:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for internal walls.....	35
<b>Figure 4.15:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 15 floors for external walls.....	35
<b>Figure 4.16:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 15 floors for external walls.....	35
<b>Figure 4.17:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 25 floors for $t_{wall}=20cm$ .....	39
<b>Figure 4.18:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 25 floors for $t_{wall}=20cm$ .....	39
<b>Figure 4.19:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 25 floors for $t_{wall}=30cm$ .....	39
<b>Figure 4.20:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 25 floors for $t_{wall}=30cm$ .....	39
<b>Figure 4.21:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 25 floors for internal walls.....	40
<b>Figure 4.22:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 25 floors for internal walls.....	40
<b>Figure 4.23:</b> Acceleration vs. the statical system for buildings with floor height of 3m and number of floors of 25 floors for external walls.....	40
<b>Figure 4.24:</b> Acceleration vs. the statical system for buildings with floor height of 5m and number of floors of 25 floors for external walls.....	40

<b>Figure 4.25:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and flat slab without drop system for $t_{wall}=20\text{cm}$ .....	44
<b>Figure 4.26:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and flat slab without drop system for $t_{wall}=20\text{cm}$ .....	44
<b>Figure 4.27:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and flat slab without drop system for $t_{wall}=30\text{cm}$ .....	44
<b>Figure 4.28:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and flat slab without drop system for $t_{wall}=30\text{cm}$ .....	44
<b>Figure 4.29:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and flat slab without drop system for internal walls.....	45
<b>Figure 4.30:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and flat slab without drop system for internal walls.....	45
<b>Figure 4.31:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and flat slab without drop system for external walls.....	45
<b>Figure 4.32:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and flat slab without drop system for external walls.....	45
<b>Figure 4.33:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and flat slab with drop system for $t_{wall}=20\text{cm}$ .....	49
<b>Figure 4.34:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and flat slab with drop system for $t_{wall}=20\text{cm}$ .....	49
<b>Figure 4.35:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and flat slab with drop system for $t_{wall}=30\text{cm}$ .....	49
<b>Figure 4.36:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and flat slab with drop system for $t_{wall}=30\text{cm}$ .....	49
<b>Figure 4.37:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and flat slab with drop system for internal walls.....	50
<b>Figure 4.38:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and flat slab with drop system for internal walls.....	50
<b>Figure 4.39:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and flat slab with drop system for external walls.....	50
<b>Figure 4.40:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and flat slab with drop system for external walls.....	50

<b>Figure 4.41:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and solid slab system for $t_{wall}=20\text{cm}$ .....	54
<b>Figure 4.42:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and solid slab system for $t_{wall}=20\text{cm}$ .....	54
<b>Figure 4.43:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and solid slab system for $t_{wall}=30\text{cm}$ .....	54
<b>Figure 4.44:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and solid slab system for $t_{wall}=30\text{cm}$ .....	54
<b>Figure 4.45:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and solid slab system for internal walls.....	55
<b>Figure 4.46:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and solid slab system for internal walls.....	55
<b>Figure 4.47:</b> Acceleration vs. the number of floors for buildings with floor height of 3m and solid slab system for external walls.....	55
<b>Figure 4.48:</b> Acceleration vs. the number of floors for buildings with floor height of 5m and solid slab system for external walls.....	55
<b>Figure 4.49:</b> Drift values for models having 15 floor.....	56
<b>Figure 4.50:</b> Drift values for models having 20 floor.....	57
<b>Figure 4.51:</b> Drift values for models having 25 floor.....	58
<b>Figure 4.52:</b> Static vs. Dynamic displacement for model 20FSIN203.....	60
<b>Figure 4.53:</b> Static vs. Dynamic displacement for model 20FSXT203.....	60
<b>Figure 4.54:</b> Static vs. Dynamic displacement for model 20FSDIN203.....	61
<b>Figure 4.55:</b> Static vs. Dynamic displacement for model 20FSDXT203.....	61
<b>Figure 4.56:</b> Static vs. Dynamic displacement for model 20FSDXT205.....	62
<b>Figure 4.57:</b> Static vs. Dynamic displacement for model 20SDIN203.....	62
<b>Figure 4.58:</b> Static vs. Dynamic displacement for model 20SDXT203.....	63
<b>Figure 4.59:</b> Static vs. Dynamic displacement for model 20SDIN205.....	63
<b>Figure 4.60:</b> Static vs. Dynamic displacement for model 30FSDXT203.3.....	64
<b>Figure 4.61:</b> Static vs. Dynamic displacement for model 25FSDXT204.....	64

<b>Figure 4.62:</b> Static vs. Dynamic displacement for model 30SDIN203.3.....	65
<b>Figure 4.63:</b> Static vs. Dynamic displacement for model 25SDIN204.....	65
<b>Figure 4.64:</b> : Comparison between dynamic of external vs. internal shear wall for 20 story building with flat slab and 3m floor height and 20mm shear wall (20FSIN203 vs. 20FSXT203) dynamic displacement.....	66
<b>Figure 4.65:</b> Comparison between dynamic of external vs. internal shear wall for 20 story building with flat slab with drop and 3m floor height and 20mm shear wall (20FSDIN203 vs. 20FSDXT203) dynamic displacement.....	66

# Abstract

Design of tall and medium rise buildings is usually governed by wind loads rather than seismic loads. Generally, designers would consider the influence of wind loads represented as static loads on the resulting straining actions and drift values. Traditional representation of wind excitation may not capture the influence on the human comfort limits which are affected by many factors including the dynamic properties of the building, usage of areas, expected wind excitations...etc.

In this research, a parametric study is conducted to investigate the influence of a number of parameters including the used structural system, number of floors, and floor height on the performance of medium rise reinforced concrete buildings under wind loading effects. Total of 92 models are examined using linear static and dynamic analyses. Human comfort limits are usually related to the acceleration values of buildings. Hence, in the current study, focus is given to acceleration and drift values as measures of the human comfort levels in the range of the studied structures. Static and dynamic time history analyses are employed in the performed parametric study.

In addition, limits and recommendations imposed by different codes and standards to satisfy human comfort requirements are explored and listed.

# **Chapter 1 : Introduction**

## **1.1. Introduction**

Civil structures are traditionally designed to resist static loads. They are, however, subjected to a variety of dynamic loads, including wind and earthquakes. Neglecting the dynamic nature of such loads may cause severe vibratory motion which hinders the usage of the structure.

## **1.2. Problem Statement**

Wind loads have traditionally been modeled using static force equivalents. The procedure for applying wind loads includes determining basic wind speed value which corresponds to an extreme velocity measured at a height of 10 m and averaged over a period of 3 seconds and has a return period of 50 years. Afterwards, the basic wind speed is adjusted to account for topology, ground roughness, structure shape, and height above ground. Hence, the resulting wind speed is converted into static pressure acting upon the surface area of the structure.

However, in some cases, it is not deemed sufficient to treat wind loads as static forces. The dynamic response of structures to wind loads can be assessed analytically or experimentally. In addition, vibration effects in medium rise and high rise buildings may result in discomfort conditions for occupants.

Design codes and standards provide guidelines for the acceptable acceleration ranges for different structures. Such guidelines are usually related to the acceptable range of acceleration. Meanwhile, most common design applications focus on the strength of the building and its ability to resist the applied loads with no consideration to the dynamic nature of wind excitations.

A parametric study is carried out for the evaluation of resulting acceleration values for a wide range of medium rise reinforced concrete structures. This work focuses mainly on conventional reinforced concrete buildings for office occupancy.

## **1.3. Scope of the Research**

The need to assess the limits of human comfort adopted in different codes and whether conventional design of reinforced concrete buildings satisfies such limits is the main point of this research work. The research program includes:

1. Investigating acceleration values for medium rise reinforced concrete buildings considering different systems.
2. Comparing response of medium rise reinforced concrete buildings under static and dynamic representation of wind loads.
3. Exploring the human comfort limits and recommendations stipulated in different codes and standards.