



بسم الله الرحمن الرحيم  
Sudan University of Science and Technology  
College of Graduate Studies

**Analysis of High-Rise Buildings Under Cyclic Loads**  
(Wind and Earthquakes Loads)

تحليل مقاومة المباني العالية للأحمال الدورية  
(الزلازل والرياح)

By

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Thesis Submitted to the College of Engineering Sudan  
University of Science and Technology for the Partial Fulfillment of the

Degree of

Master of Science

In

Civil Engineering  
(Construction Engineering)

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بسم الله الرحمن الرحيم

:قال تعالى

أم حسبتم أن تدخلوا الجنة ولما يأتكم {  
مثل الذين خلوا من قبلكم مستهم البأساء  
والضراء وزلزلوا حتى يقول الرسول  
والذين آمنوا معه متى نصر الله إلا إن نصر  
}الله قريب.  
صدق الله العظيم

(سورة البقرة آية 214)

# Dedication

*In Memory of my mother  
And  
In Love of my Father*

## Abstract

This research is concerned with the study of the effects of wind and earthquakes on tall buildings. Tall buildings are buildings in which the slenderness ratios (heights to the smaller plan dimensions) are large, this makes such buildings more exposed to the horizontal forces resulting from wind, earthquakes, water pressure and other similar actions. This research is concerned with just wind and earthquakes because they have more probability to occur in Sudan.

Many structural forms are used to resist horizontal forces like frame systems, shear walls and combined systems.

A study of a building consisting of twenty stories has been done by analyzing it using the computer program (ETABS9). The analysis was carried out for the building under three different systems of load, namely (D.L+L.L), wind loads and earthquakes loads. A comparison has been made between wind and earthquakes loads as additional loads applied on the building besides its own loads (D.L+L.L) so as to study the effect of wind and earthquakes loads on tall building and what to expect when those loads are neglected. These results are displayed on figures to explain their effect the on buildings. Based on these results some recommendations have been drawn for the structural engineers to consider in the design stage of high-rise buildings subject to wind and earthquakes.

## II

### تجريد

يهتم هذا البحث بدراسه أثر أحمال الرياح واحمال الزلازل علي الأبنية العاليه , والابنية العالية

هي المباني التي تكون فيها نسبة النحافة (اي نسبة الارتفاع الي البعد الافقي الاصغر)عالية مما

يجعلها اكثر تأثرا بال قوي الافقية مثل حمولات الرياح والزلازل وضغط الماء والحوادث الاخري

.المتشابهة

في هذه الدراسة تم التعامل مع احمال الرياح واحمال الزلازل فقط لان لهما نسبة احتمال حدوث اكبر

.في السودان م مقارنة بالكوارث الاخري

تستخدم عدة انظمة انشائية لمقاومة الاحمال الافقية منها النظم الاطارية وحوائط القص والنظم

.المشتركة

تمت دراسة مبني مكون من عشرين طابقا وتم تحليل هذا المبني بواسطه برنامج الحاسوب (ايتابس9)

تحت تأثير القوي الافقية للرياح والزلازل وتمت م مقارنة هذه النتائج مع نتائج تحليل المبني تحت

تأثير وزنه الذاتي وذلك لدراسة اثر حمولات الرياح والزلازل علي الابنية العالية وماهو المتوقع اذا

تم تجاهل هذه الاحمال، عرضت هذه النتائج في شكل مخططات توضح اثر كل من حمولات

الرياح وحمولات الزلازل على المبني بالإضافة لتأثير وزنه الذاتي . وعلى ضوء هذه النتائج  
تم وضع

مقترحات ليأخذ بها مهندسو التصميم عند تصميم المباني العالية المعرضة لاحمال الرياح  
وأحمال الزلازل.

### III

## **Acknowledgement**

There are a number of people to whom I am deeply indebted to and would like to acknowledge their contributions towards this research.

It is my pleasure to express my utmost gratitude and appreciation to my supervisor Dr. ABDEL RAHMAN ALZUBAIR MOHEMED for his close supervision, guidance, constructive discussion and criticism throughout the different stages of the study.

I would like also to extend my thankfulness to all my teachers who have encouraged me in the past.

I would like to express my boundless gratefulness to my brother, Mr. Imadeldeen, who has given me encouragement and wisdom throughout the ordeal, my father, who made this possible at the beginning, to my mother who did not live to share the success, to my brothers and sisters, I thank them for creating footsteps for me to follow.

Sincere gratitude and appreciation are due to my friends for their moral support and continuous encouragement.

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### **Conclusions and Recommendations**

#### **5.1 Conclusions:**

From this research and the results obtained it can be concluded that:

- 1- The special provisions required for the design of towers subjected to cyclic loading were studied by carrying out a comprehensive literature review.
- 2- Wind and earthquake loads were determined as shown in chapter four.
- 3- Wind loads calculations were carried out using the British standard (BS6399).
- 4- A study of the finite element method to analyze structure under wind and earthquake loading using a computer program was carried out as shown in chapter four.
- 5- The analysis of a specific tall building under cyclic loads was carried out using the computer program ETABS (9).
- 6- A comparison of the results of the analysis of the specific building under own weight, under wind loading, under earthquake loading.

- 7- A comparison shows that there is a large drift for wind and earthquake loads.
- 8- There are large alterations in axial loads on columns due to wind and earthquake loads.
- 9- Torsional variable moments result on beams from wind and earthquake loads. There is no remarkable variation in bending moments and shear forces.
- 10- Studying the P- $\Delta$  analysis which is particularly useful for considering the effect of gravity loads upon the lateral stiffness of building structures due to time limitations.

## 5.2 Recommendations:

For further research in the field of wind and seismic loadings on tall buildings it is recommended that:

- 1- The effect of special of foundation related to the tall buildings under cyclic loading should be considered.
- 2- Tuned liquid dampers to upgrade the seismic resistance of the structure should be studied.
- 3- Special constructions methods of tall buildings subjected to seismic loading must be considered.
- 4- More data of earthquake in Sudan should be collected.
- 5- The P- $\Delta$  analysis which is particularly useful for considering the effect of gravity loads upon the lateral stiffness of building structures for linear and nonlinear load displacement relations must be studied.

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