



Cairo University

STAGED CONSTRUCTION ANALYSIS OF REINFORCED CONCRETE BUILDINGS WITH DIFFERENT LATERAL LOAD RESISTING SYSTEMS

By

Mohamed Ibrahim Metwally Mohamed Ibrahim

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
STRUCTURAL ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2020

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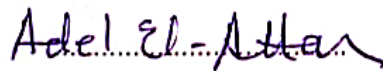
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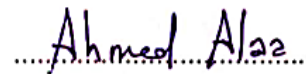
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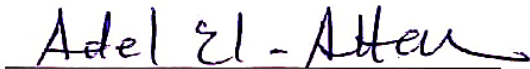
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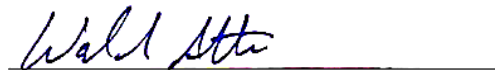
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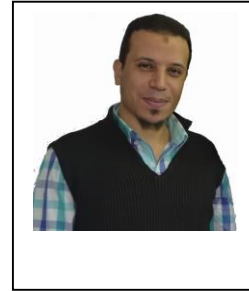
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Title of Thesis:

"Staged Construction Analysis of Reinforced Concrete Buildings with Different Lateral Load Resisting Systems"

Key Words:

Tall Buildings; Lateral Load Resisting Systems; One Step Analysis; Staged-Construction Analysis; Shrinkage and Creep.

Summary:

Practitioners used to analyze Reinforced Concrete (RC) buildings using the One Step Analysis (OSA), where loads are applied to the whole structure as one unit. However, this assumption is not realistic because buildings are constructed storey by storey and dead load acts sequentially. This sequential nature of construction is considered in a more accurate approach which is called Staged-Construction Analysis (SCA). Current codes for RC structures are limited to OSA and they do not provide any provisions for SCA. In this research, a nonlinear Finite Element Model (FEM) for SCA of RC buildings is developed using the commercial software, MIDAS-Gen. The developed model accounts for time dependent effects such as shrinkage and creep. The model is utilized to analyze RC buildings with Rigid Frame (RF), Shear Wall (SW), Wall-Frame (WF) and Tube in Tube (TT) systems. Design parameters for the studied buildings are selected according to the current codes.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

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Signature:

Dedication

For my teacher ***Prof. Dr. Salah El-Din E. El-Metwally***, who has encouraged me to complete my PhD in structural engineering department at Cairo university. He has not been only a teacher for me but father.

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In the name of Allah, praise is to Allah, prayer and peace is upon the Messenger of Allah, the prophet Mohammed-peace is upon him-. Allah is the first and the last who, always guided and aided me to bring-forth for the achievement of this work. All praise and thanks are due to the Almighty Allah. There are many people whom I have to acknowledge for their support, help and encouragement during the journey of preparing this thesis. So, I will make an effort to give them their due here, and I sincerely apologize for any inattention.

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Finally, O Allah make this work purely for you alone, O Lord of the Worlds.

Mohamed Ibrahim Metwally, 2020

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List of Symbols, Abbreviations and Nomenclature

<i>ACI</i>	American concrete institute
<i>ASCE</i>	American society of civil engineers
<i>B</i>	Beam
<i>B.M.D</i>	Bending moment diagram
<i>B_d</i>	Building
<i>BDD</i>	Beam differential displacements
<i>BM</i>	Bending moments
<i>BT</i>	Bundled tube
<i>C</i>	Column
<i>CDS</i>	Column differential shortenings
<i>CEB-FIP</i>	International federation for structural concrete, Comité Européen du Béton- Fédération internationale du béton
<i>Conc. Cast.</i>	Concrete Casting
<i>Conf.</i>	Configuration
<i>DAS</i>	Differential axial shortening
<i>DD</i>	Differential displacement
<i>Diff. %</i>	Difference in percentage between staged-construction analysis and one-step analysis
<i>Diff.a</i>	Difference between staged-construction analysis and one-step analysis after mitigation
<i>Diff.b</i>	Difference between staged-construction analysis and one-step analysis before mitigation
<i>DMF</i>	Dimension modification factor
<i>D_N</i>	New dimensions
<i>D_O</i>	Old dimensions
<i>E_c</i>	Modulus of elasticity of concrete
<i>E_s</i>	modulus of elasticity of steel

<i>ECP</i>	Egyptian Code of Practice
<i>ETABS</i>	Extended three dimensional analysis of building structures
<i>F</i>	Floor
f_c	Characteristic strength of concrete
<i>FEM</i>	Finite element model
<i>Formwork Inst.</i>	Formwork insulation
f_u	Ultimate stress of steel
f_y	Yield stress of steel
<i>GA</i>	Genetic algorithm
<i>HRB</i>	High-rise buildings
<i>LLRS</i>	Lateral load resisting systems
<i>LRB</i>	Low rise buildings
M_Δ	Bending moment due to differential displacement
<i>midas Gen.</i>	midas Generation
M_{OSA}	Bending moment due to one-step analysis
<i>MPA</i>	Mineral products association
M_{SCA}	Bending moment due to Staged-construction analysis
<i>OSA</i>	One-step analysis
<i>OT</i>	One tube
<i>RC</i>	Reinforced concrete
<i>RF</i>	Rigid frame
<i>S</i>	Slab strip
<i>S.F.D</i>	Shear force diagram
<i>SCA</i>	Staged-construction analysis
<i>SCAN</i>	Staged-construction analysis neglecting time dependent effects
<i>SCAT</i>	Staged-construction analysis including time dependent effects