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
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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.

Name: *Mohamed Ibrahim Metwally Mohamed Ibrahim* Date: ...../...../2020

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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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Mohamed Ibrahim Metwally, 2020

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List of Symbols, Abbreviations and Nomenclature

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

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