EVALUATION OF HIGH RISE CONCRETE STRUCTURES BEHAVIOR UNDER SEISMIC LOADS USING PERFORMANCE BASED METHOD

By

Elhussein Ibrahim Elsayed Elsayed

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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Under the supervision of

Prof. Dr. Sherif Ahmed Mourad

Professor of Steel Structures and Bridges

Structural Engineering Department

Faculty of Engineering

Cairo University

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Approved by the
Examining Committee

Prof. Dr. Sherif Ahmed Mourad, Thesis Advisor
Structural Engineering Department
Faculty of Engineering, Cairo University

_____

Prof. Dr. Wael Muhammed El-Degwy, Examiner
Structural Engineering Department
Faculty of Engineering, Cairo University

_____

Prof. Dr. Emad Elsayed Etman, Examiner
Structural Engineering Department
Faculty of Engineering, Tanta University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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2014

Engineer: Elhussein Ibrahim Elsayed Elsayed
Date of Birth: 1 / 1 / 1983
Nationality: Egyptian
E-mail: elhussin.ibrahim@yahoo.com
Phone. : 01222759140
Address: 52 – 3rd settlement – New Cairo, Cairo

Registration Date: 1/ 10 / 2009
Awarding Date: / /
Degree: Master of Science
Department: Structural Engineering
Supervisors: Prof. Dr. Sherif Ahmed Mourad

Examiners: Prof. Dr. Sherif Ahmed Mourad
Prof. Dr. Wael Mohamed Eldegwy
Prof. Dr. Emad Elsayed Etman
(Professor of concrete structures – Faculty of Engineering – Tanta University)

Title of Thesis: EVALUATION OF HIGH RISE CONCRETE STRUCTURES BEHAVIOR UNDER SEISMIC LOADS USING PERFORMANCE BASED METHOD

Key Words: (Performance Based, Time History, Nonlinear analysis, Force Based and Seismic Behavior)

Summary:

Seismic design has undergone a remarkable development during the past decades. A simple approach may be established using equivalent static load method. A more elaborate modelling may be achieved by a dynamic time history analysis to improve the judgment on structures behavior during earthquakes. A parametric study was conducted for different (RC) structures. These structures were firstly designed according to the (IBC) code requirements, and then were evaluated using performance based method by subjecting them to earthquake ground motions to come up with conclusions to be taken into consideration during the design process.

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First of all, I would like to convey my warmest gratitude to my supervisor professor Dr. Sherif Ahmed Mourad, who gave me the opportunity to conduct my study under his supervision, and for his guidance, generous contribution of knowledge and experience, valuable comments and encouragement from the start until the end of my study. Also my deepest respect, love and gratitude to my Uncle Mr. Mahmoud Zaki, who taught me so many things. May God bless his soul in Heaven.

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List of Abbreviations

ADRS	Acceleration Displacement Response Spectrum
ASCE	American Society of Civil Engineers
ATC	Applied Technology Council
CEN	European Committee for Standardization
CQC	Complete Quadratic Combination
CSI	Computer and Structure Institute
CSM	Capacity Spectrum Method
DCB	Deformation Calculation Based
DDSB	Direct Deformation Specification Based
FBSD	Force Based Seismic Design
FEMA	Federal Emergency Management Agency
IBC	International Building Code
ICBO	International Conference of Building Officials
IDSB	Iterative Deformation Specification Based
LDP	Linear Dynamic Procedure
LFRS	Lateral Force Resisting System
LSP	Linear Static Procedure
MDOF	Multi Degree of Freedom
NDP	Nonlinear Dynamic Procedure
NEHRP	National Earthquake Hazards Reduction Program
NSP	Nonlinear Static Procedure
OMRF	Ordinary Moment Resisting Frame

PBSD	Performance Based Seismic Design
PEER	Pacific Earthquake Engineering Research Center
PGA	Peak Ground Acceleration
PGD	Peak Ground Displacement
PGV	Peak Ground Velocity
RC	Reinforced Concrete
SDOF	Single Degree of Freedom
SEAOC	Structural Engineers Association of California
SMRF	Special Moment Resisting Frame
SRSS	Square Root of the Sum of the Squares
UBC	Uniform Building Code
ZPA	Zero Period Acceleration

Abstract

Structures seismic design has undergone a remarkable development during the past decades. A simple approach may be established using equivalent static load method. This approach was improved by utilizing the response spectrum method, and introducing the response modification factor (R) to capture the structure ductility and inelastic behavior, where structure can dissipate the absorbed energy from earthquakes via concrete cracks and yielding of reinforcement. A more elaborate modelling may be achieved by a dynamic time history analysis to improve the engineering judgment on structures behavior during earthquakes. The current design philosophy, included in the majority of international codes as well as the Egyptian code for loads, was based on the "force based approach" in which the design safety is reached when the requirements of resistance, ductility and equilibrium limit state conditions are achieved. Serviceability limit state conditions of deformations and drifts are checked at the end of the design process.

Recently, in an attempt to reach a more realistic design, another design philosophy called "Performance based approach" was introduced. Performance based approach focuses on the structural performance during earthquake. One of the major benefits of the performance based approach is achieving the uniform risk principle in structures seismic design, which is not provided by implementing the traditional force based approach. This research includes evaluation of seismic behavior of two types of reinforced concrete high rise buildings: one of them is shear wall system and the other one is dual system comprised of shear walls in addition to ordinary reinforced concrete moment resisting frames. A detailed parametric study was conducted for these different lateral load resisting systems. These structures were firstly designed according to the international building code (IBC) requirements, and then their performance was checked by subjecting them to three earthquake ground motions as will be fully described in the research methodology. Final conclusions will be highlighted based on a full sets of results and discussion.