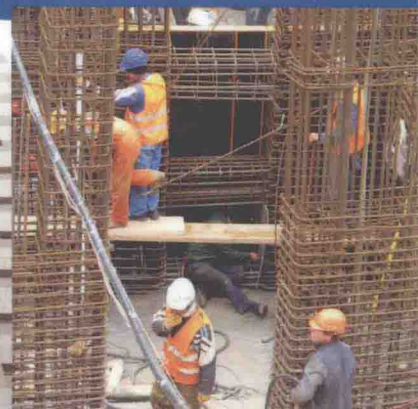



Concrete Buildings in Seismic Regions

George G. Penelis and Gregory G. Penelis



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Preface

This book is addressed primarily to postgraduate students in earthquake engineering and to practising structural engineers specialising in the design of R/C seismic-resistant buildings.

The following basic aims have guided the composition of the material of this book:

1. The presentation of the content should be characterised by integrity, clarity and simplicity, particularly for the design procedure of new R/C buildings or assessment and retrofitting of existing ones. In this respect it should constitute integrated knowledge for a student. The long experience of the first of the authors in teaching undergraduate and postgraduate students about R/C earthquake-resistant structures augurs well for the achievement of this aim.
2. The presentation of the scientific background of each subject should be made in a concise form with all the necessary—but at the same time, limited—references to the sources so that enough of an open field is available for a rigorous and systematic approach to the implementation of the scientific background in design procedure. In this context, this book would be valuable for practising engineers who want to have in-depth knowledge of the background on which the code rules are based. The extensive experience of both authors in the seismic design of new R/C buildings and in the assessment and retrofitting of existing ones, together with the wide experience of the first in posts of responsibility in seismic risk management in Greece, contribute to a balanced merging of the scientific background with practical design issues. At the same time, the numerical examples that are interspersed in the various chapters also intend to serve this aim.
3. For furtherance of the above aims, all of the material of the book has been adjusted to fit a modern Seismic Code of broad application, namely, EN1998/2004-5 (EC8/2004-5), so that quantitative values useful for the practice are presented. At the same time, comparative references are made to the American Standards in effect for seismic design. It is obvious that this choice covers the design requirements for Europe. At the same time, the comparative references to the American Standards enable an easy adjustment of the content to the American framework of codes.

In closing, we express our thanks to the following collaborators for their contributions to the preparation of this book.

- *Professor Andreas Kappos*, co-author with G. Penelis of the book titled, *Earthquake Resistant Concrete Structures* (1997). We are grateful for his consent to reproduce a number of illustrations and some parts of the text from the abovementioned book.
- *Dr. Georgia Thermou*, lecturer in engineering at AUTH and *John Papargyriou* MSc-DIC for their contributions in the elaboration of the numerical examples.

- *Dr. Phil Holland* for correction and improvement of the language of the text.
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- *Tony Moore*, senior editor of Spon Press for his efforts in coordinating the publication of the book.

George Gr. Penelis
Gregory G. Penelis

Abbreviations

ACI	American Concrete Institute
ADRS	Acceleration Displacement Response Spectra
AEL	Annualised Earthquake Loss
AELR	Annualised Earthquake Loss Ratio
AFRP	Aramid Fibres
ASCE	American Society of Civil Engineers
ATC	Applied Technology Council
AUTH	Aristotle University of Thessaloniki
B/C	Benefit/Cost
BI	Bilinear Form
BTM	Building Typology Matrix
CEB	Comité Euro-International du Béton
CEN	European Committee for Standardization
CF	Confidence Factor
CFRP	Carbon Fibres
CQC	Complete Quadratic Combination
DBD	Displacement-Based Design
DCH	Ductility Class High
DCL	Ductility Class Low
DCM	Ductility Class Medium
DDBD	Direct Displacement-Based Design
DIN	Deutsches Institut für Normung
DL	Damage Limitation
DLS	Damage Limitation State
DPM	Damage Probability Matrix
DSA	Design Seismic Action
DT	Destructive Test
EERI	Earthquake Engineering Research Institute
ELOT	Greek Organization for Standardization
EMS-98 scale	European Macroseismic
EN1990-1999	Eurocodes EC0-EC9
ENV1990-1999	Eurocodes EC8-EC9 (voluntarily)
EPP	Elastic-Perfectly Plastic
EUROCODES (EC-CODES)	European Standards
FEM	Finite Element Method
FEMA	Federal Emergency Management Agency
FIB	International Federation for Structural Concrete
FRP	Fiber-Reinforced Plastic

GFRP	Glass Fibres
GIS	Geographic Information System
GMPW	Greek Ministry of Public Works
GNP	Gross National Product
HAZUS-MH	Hazards US-Multi Hazard
ICSSC	Interagency Committee on Seismic Safety in Construction
IDA	Inelastic Dynamic Analysis
JBDPA	Japan Building Disaster Prevention Association
LS	Limit State
MDOF	Multi-Degree-of-Freedom
MEP	Mechanical Electrical Plumbing
MM scale	Modified Mercalli scale
MRF	Moment Resisting Frames
MSK scale	Medvedev, Sponheuer, Karnik scale
NAD	National Application Document
NC	Near Collapse
NDT	Non-Destructive Test
NIBS	National Institute of Buildings Sciences
NTU	National Technical University of Greece
NZS	New Zealand Code
OASP	Seismic Risk Management Agency of Greece
OCR	Over Consolidation Ratio
PESH	Potential Earth-Science Hazard
PGA	Peak Ground Acceleration
PGD	Peak Ground Displacement
PGV	Peak Ground Velocity
PSV	Pseudovelocity Spectra
R/C	Reinforced Concrete
RILEM	International Union of Laboratories and Experts in construction materials
RISK-UE	Risk-Union European
RVSP	Rapid Visual Screening Procedure
SD	Significant Damage
SDOF	Single-Degree-of-Freedom
SEAOC	Structural Engineers Association of California
SI	Seismic Intensity
SIA	Schweizerische Normenvereinigung
SRSS	Square Root of the Sum of the Squares
TR	Torsionally Restrained System
TUR	Torsionally Unrestrained System
ULS	Ultimate Limit State
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization

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