Performance Based Seismic Design Rising

Proceedings of the International Symposium on Computational Structural Engineering, held in Shanghai, China, June 22–24, 2009
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Seismic Design of RC Buildings

SYLVIA CLARK

Proceedings of the International Symposium on Computational Structural Engineering, held in Shanghai, China, June 22–24, 2009
Springer
This book provides a single-source reference for whole life embodied impacts of buildings. The comprehensive and persuasive text, written by over 50 invited experts from across the world, offers an indispensable resource both to newcomers and to established practitioners in the field. Ultimately it provides a persuasive argument as to why embodied impacts are an essential aspect of sustainable built environments. The book is divided into four sections: measurement, including a strong emphasis on uncertainty analysis, as well as offering practical case studies of individual buildings and a comparison of materials; management,

focusing in particular on the perspective of designers and contractors; mitigation, which identifies some specific design strategies as well as challenges; and finally global approaches, six chapters which describe in authoritative detail the ways in which the different regions of the world are tackling the issue.

Embodied Carbon in Buildings

Trans Tech Publications Ltd

This volume gathers the latest advances, innovations, and applications in the field of seismic engineering, as presented by leading researchers and engineers at the 1st International Workshop on Energy-Based Seismic Engineering (IWEBSE), held in Madrid, Spain, on May 24-26, 2021. The contributions cover a diverse range of topics, including energy-based EDPs, damage potential of ground motion, structural modeling in energy-based damage assessment of structures, energy dissipation demand on structural components, innovative structures with energy dissipation systems or seismic isolation, as well as seismic design and analysis. Selected by means of a rigorous peer-review process, they will spur novel

research directions and foster future multidisciplinary collaborations.

Improved Seismic Monitoring - Improved Decision-Making

Springer Science & Business Media

This book contains 9 invited keynote and 12 theme lectures presented at the 14th European Conference on Earthquake Engineering (14ECEE) held in Ohrid, Republic of Macedonia, from August 30 to September 3, 2010. The conference was organized by the Macedonian Association for Earthquake Engineering (MAEE), under the auspices of European Association for Earthquake Engineering (EAEE). The book is organized in twenty one state-of-the-art papers written by carefully selected very eminent researchers mainly from Europe but also from USA and Japan. The contributions provide a very comprehensive collection of topics on earthquake engineering, as well as interdisciplinary subjects such as engineering seismology and seismic risk assessment and management. Engineering seismology, geotechnical earthquake engineering, seismic performance of buildings, earthquake resistant engineering structures, new

techniques and technologies and managing risk in seismic regions are all among the different topics covered in this book. The book also includes the First Ambraseys Distinguished Award Lecture given by Prof. Theo P. Tassios in the honor of Prof. Nicholas N. Ambraseys. The aim is to present the current state of knowledge and engineering practice, addressing recent and ongoing developments while also projecting innovative ideas for future research and development. It is not always possible to have so many selected manuscripts within the broad spectrum of earthquake engineering thus the book is unique in one sense and may serve as a good reference book for researchers in this field. Audience: This book will be of interest to civil engineers in the fields of geotechnical and structural earthquake engineering; scientists and researchers in the fields of seismology, geology and geophysics. Not only scientists, engineers and students, but also those interested in earthquake hazard assessment and mitigation will find in this book the most recent advances.

High-Rise Buildings under Multi-Hazard Environment

Springer Nature

These proceedings, arising from an international workshop, present research results and ideas on issues of importance to seismic risk reduction and the development of future seismic codes. *Proceedings of the Sixth International Conference on Structural Engineering, Mechanics and Computation, Cape Town, South Africa, 5-7 September 2016* fib Fédération internationale du béton Collection of selected, peer reviewed papers from the 2014 International Conference on Civil, Architechture and Building Materials (CEABM 2014), May 24-25, 2014, Haikou, China. The 312 papers are grouped as follows: Chapter 1: Structural Engineering, Chapter 2: Monitoring and Control of Structures, Chapter 3: Structural Rehabilitation, Retrofitting and Strengthening , Chapter 4: Reliability and Durability of Structures Perspectives on European Earthquake Engineering and Seismology IGI Global This multi-contributor book provides comprehensive coverage of earthquake engineering problems, an overview of traditional methods, and the scientific background on recent developments. It discusses computer methods on

structural analysis and provides access to the recent design methodologies and serves as a reference for both professionals and res

Inelastic Methods of Analysis and Case Studies

Springer Nature

Performance-Based Seismic Design (PBSD) is a structural design methodology that has become more common in urban centers around the world, particularly for the design of high-rise buildings. The primary benefit of PBSD is that it substantiates exceptions to prescribed code requirements, such as height limits applied to specific structural systems, and allows project teams to demonstrate higher performance levels for structures during a seismic event.Howeve r, the methodology also involves significantly more effort in the analysis and design stages, with verification of building performance required at multiple seismic demand levels using Nonlinear Response History Analysis (NRHA). The design process also requires substantial knowledge of overall building performance and analytical modeling, in order to proportion and detail structural systems to meet specific performance objectives.Thi s CTBUH

Technical Guide provides structural engineers, developers, and contractors with a general understanding of the PBSD process by presenting case studies that demonstrate the issues commonly encountered when using the methodology, along with their corresponding solutions. The guide also provides references to the latest industry guidelines, as applied in the western United States, with the goal of disseminating these methods to an international audience for the advancement and expansion of PBSD principles worldwide.

Measurement, Management, and Mitigation

Springer

This handbook contains up-to-date existing structures, computer applications, and infonnation on planning, analysis, and design seismic design of wood structures. A new and very useful feature of this edition of earthquake-resistant building structures. Its intention is to provide engineers, architects, is the inclusion of a companion CD-ROM disc developers, and students of structural containing the complete digital version of the handbook itself and the following very engineering and architecture with

authoritative, yet practical, design infonnation. It represents important publications: an attempt to bridge the persisting gap between l. UBC-IBC (1997-2000) Structural advances in the theories and concepts of Comparisons and Cross References, ICBO, earthquake-resistant design and their 2000. implementatio n in seismic design practice. 2. NEHRP Guidelines for the Seismic The distinguished panel of contributors is Rehabilitation of Buildings, FEMA-273, Federal Emergency Management Agency, composed of 22 experts from industry and universities, recognized for their knowledge and 1997. extensive practical experience in their fields. 3. NEHRP Commentary on the Guidelinesfor They have aimed to present clearly and the Seismic Rehabilitation of Buildings, FEMA-274, Federal Emergency concisely the basic principles and procedures pertinent to each subject and to illustrate with Management Agency, 1997. practical examples the application of these 4. NEHRP Recommende d Provisions for principles and procedures in seismic design Seismic Regulations for New Buildings and

practice. Where applicable, the provisions of Older Structures, Part 1 - Provisions, various seismic design standards such as mc FEMA-302, Federal Emergency 2000, UBC-97, FEMA-273/274 and ATC-40 Management Agency, 1997. Frontiers of Green Building, Materials and Civil Engineering Iuss Press "TRB's National Cooperative Highway Research Program (NCHRP) Synthesis 440, Performance-Based Seismic Bridge Design (PBSD) summarizes the current state of knowledge and practice for PBSD. PBSD is the process that links decision making for facility design with seismic input, facility response, and potential facility damage. The goal of PBSD is to provide decision makers and stakeholders with data that will enable them to allocate resources for construction based on levels of desired seismic performance"--Publisher's description. *Earthquake-resistant Steel Structures* Springer Science & Business Media Performance Based Seismic Design for Tall BuildingsAn Output of the CTBUH Performance Based Seismic Design Working Group **Integrated Seismic Design of Structure**

and Control Systems Transportation Research Board This fascinating new book examines the issues of earthquake geotechnical engineering in a comprehensive way. It summarizes the present knowledge on earthquake hazards and their causative mechanisms as well as a number of other relevant topics. Information obtained from earthquake damage investigation (such as ground motion, landslides, earth pressure, fault action, or liquefaction) as well as data from laboratory tests and field investigation is supplied, together with exercises/questions. Seismic Performance of Slender Reinforced Concrete Structural Walls CRC Press Large investments have recently been made for the construction of new medium- and high-rise buildings in California. In many cases performance-based designs have been the preferred method for these buildings. A main consideration in performance-based seismic design is the estimation of the likely development of structural and nonstructural damage limit-states given a hazard level. For this type of buildings efficient modeling

techniques are required able to compute the response at different performance states. A research work was conducted at University of California San Diego (UCSD) on the i) seismic design, ii) experimental response and iii) computational modeling of medium- and high-rise reinforced concrete wall buildings. In the first part of this work a displacement-based seismic design method for use within performance-based is developed. Capacity design is used to control the mechanism of inelastic deformation. Based on principles of plastic analysis and structural dynamics the new formulation allows the computation of the effects of system overstrength and of the higher modes of response. Equal emphasis is given to displacement, force and acceleration demand parameters. The ground motion destructiveness potential is also determined. Application of the method to reinforced concrete wall buildings is discussed. The method is validated with the experimental response of a full-scale 7 story building. In addition a dual plastic hinge design concept for improving the performance and optimizing the construction of high-rise

buildings is presented. The second part presents the experimental research program, with extensive shake table tests, of a full-scale 7-story reinforced concrete wall building slice, that was conducted at UCSD. The base shear coefficient obtained by the proposed method, of the first part of the research work, described above was 50% of that required by the equivalent static method prescribed by the ASCE-7 code. In spite of the reduced amount of longitudinal reinforcing steel, all performance objectives were met. The response of the building was significantly influenced, as expected, by the interaction of the main lateral force resisting wall with other structural elements (kinematic overstrength) and by the higher modes of response. Finally the third part presents a dynamic nonlinear strut-and-tie modeling approach developed for the analysis and evaluation of damage limit-states in reinforced concrete walls. The modeling approach is verified with the response of the UCSD 7-story building test.

Technical report

Springer Science & Business Media

This book comprises select peer-reviewed proceedings of

the International Conference on Recent Developments in Sustainable Infrastructure (ICRDSI) 2019. The topics span over all major disciplines of civil engineering with regard to sustainable development of infrastructure and innovation in construction materials, especially concrete. The book covers numerical and analytical studies on various topics such as composite and sandwiched structures, green building, groundwater modeling, rainwater harvesting, soil dynamics, seismic resistance and control of structures, waste management, structural health monitoring, and geo-environmental engineering. This book will be useful for students, researchers and professionals working in sustainable technologies in civil engineering.

Concepts, Commentary and Worked Examples with Flowcharts

Springer Science & Business Media

Recent decades have seen a dramatic earthquake related losses. In the past ten years estimated losses were twenty times larger than in the previous 30 years combined. FEMAs expenditures related to earthquake losses have become an increasing

percentage of its disaster assistance budget. Predictions are that future single earthquakes, which will inevitably occur, may result in losses of $50-100 billion each. Losses are rising due to several factors. These include: a denser population of buildings being located in seismically active regions. an aging building stock and the increasing cost of business interruption. Nonstructural and contents damage are also large contributors to loss, especially in regions with high-technology manufacturing and health-care industries. It is this increase in losses from all hazards that has led FEMA to support actions to reduce future losses. One of these is Project Impact, an initiative to encourage loss reduction activities through partnerships at the local community level. One of the key components of Project Impact is the community's adoption and enforcement of an adequate building code. Performance Based Seismic Design (PBSD) is a methodology that provides a means to more reliably predict seismic risk in all buildings in terms more useful to building users. PBSD will benefit nearly all building users. The

PBSD methodology will be used by code writers to develop building codes that more accurately and consistently reflect the minimum standards desired by the community. A performance based design option in the code will facilitate design of buildings to higher standards and will allow rapid implementation of innovative technology. When performance levels are tied to probable losses in a reliability framework, the building design process can be tied into owner's long-term capital planning strategies, as well as numerical life cycle cost models. PBSD is not limited to the design of new buildings. With it, existing facilities can be evaluated and/or retrofitted to reliable performance objectives. Sharing the common framework of PBSD, existing buildings and new buildings can be compared equitably. It is expected that a rating system will develop to replace the currently used Probable Maximum Loss (PML) system. Such a system is highly desirable to owners, tenants, insurers, lenders, and others involved with building financial transactions. Despite its inconsistency and lack of

transparency, the PML system is widely used and a poor rating often creates the financial incentive needed for retrofit decisions. This Action Plan presents a rational and cost effective approach by which building stakeholders: owners, financial institutions, engineers, architects, contractors, researchers, the public and governing agencies, will be able to move to a performance based design and evaluation system. The Plan recognizes that there is a strong demand from stakeholder groups for more reliable, quantifiable and practical means to control building damage. It also recognizes that there is not a focused understanding among these groups as to how these goals can be obtained. This Plan describes how performance based seismic design guidelines can be developed and used to achieve these goals. It will be a vehicle to bring together the diverse sets of demands from within the stakeholder groups and distill them into cohesive and practical guidelines. It engages each of the groups in the development these guidelines, by which future building design will become more efficient and reliable.

Updated Overview

with Emphasis on Romania
Springer Displacement-Based Seismic Design of Structures is a book primarily directed towards practicing structural designers who are interested in applying performance-based concepts to seismic design. Since much of the material presented in the book has not been published elsewhere, it will also be of considerable interest to researchers, and to graduate and upper-level undergraduate students of earthquake engineering who wish to develop a deeper understanding of how design can be used to control seismic response. The design philosophy is based on determination of the optimum structural strength to achieve a given performance limit state, related to a defined level of damage, under a specified level of seismic intensity. Emphasis is also placed on how this strength is distributed through the structure. This takes two forms: methods of structural analysis and capacity design. It is shown that equilibrium considerations frequently lead to a more advantageous distribution of strength than that resulting from stiffness considerations. Capacity design considerations have been re-

examined, and new and more realistic design approaches are presented to insure against undesirable modes of inelastic deformation. The book considers a wide range of structural types, including separate chapters on frame buildings, wall buildings, dual wall/frame buildings, masonry buildings, timber structures, bridges, structures with isolation or added damping devices, and wharves. These are preceded by introductory chapters discussing conceptual problems with current force-based design, seismic input for displacement-based design, fundamentals of direct displacement-based design, and analytical tools appropriate for displacement-based design. The final two chapters adapt the principles of displacement-based seismic design to assessment of existing structures, and present the previously developed design information in the form of a draft building code. The text is illustrated by copious worked design examples (39 in all), and analysis aids are provided in the form of a CD containing three computer programs covering moment-curvature analysis (Cumbia), linear-

element-based inelastic time-history analysis (Ruaumoko), and a general fibre-element dynamic analysis program (SeismoStruct). The design procedure developed in this book is based on a secant-stiffness (rather than initial stiffness) representation of structural response, using a level of damping equivalent to the combined effects of elastic and hysteretic damping. The approach has been fully verified by extensive inelastic time history analyses, which are extensively reported in the text. The design method is extremely simple to apply, and very successful in providing dependable and predictable seismic response.

Authors Bios

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from ETH, Zurich, and Cujo, Argentina. He is co-author of two previous seismic design books “Seismic Design of Concrete and Masonry Buildings” and “Seismic Design and Retrofit of Bridges”, that are considered standard texts on the subjects.
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Michele Calvi is Professor of the University of Pavia and Director of the Centre of Research and Graduate Studies in Earthquake Engineering and Engineering Seismology (ROSE School), Istituto Universitario di Studi Superiori (IUSS) of Pavia. He has published more than 200 papers and is co-author of the book “Seismic Design and Retrofit of Bridges”, that is considered a standard text on the subject, has been involved in important construction projects worldwide, such as the Rion Bridge in Greece and the upgrading of the Bolu Viaduct in Turkey, and is coordinating several international research projects.
M.J.Kowalsky
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research, which has largely focused on the seismic behaviour of structures, has been supported by the National Science Foundation, the North Carolina and Alaska Departments of Transportation, and several industrial organizations. He is a registered Professional Engineer in North Carolina and an active member of several national and international committees on Performance-Based Seismic Design.

From Engineering Seismology to Performance-Based Engineering

Trans Tech Publications Ltd

Throughout the past few years, there has been extensive research done on structural design in terms of optimization methods or problem formulation. But, much of this attention has been on the linear elastic structural behavior, under static loading condition. Such a focus has left researchers scratching their heads as it has led to vulnerable structural configurations. What researchers have left out of the equation is the element of seismic loading. It is essential for researchers to take this into account in order to develop earthquake resistant real-world structures. Structural

Seismic Design Optimization and Earthquake Engineering: Formulations and Applications focuses on the research around earthquake engineering, in particular, the field of implementation of optimization algorithms in earthquake engineering problems. Topics discussed within this book include, but are not limited to, simulation issues for the accurate prediction of the seismic response of structures, design optimization procedures, soft computing applications, and other important advancements in seismic analysis and design where optimization algorithms can be implemented. Readers will discover that this book provides relevant theoretical frameworks in order to enhance their learning on earthquake engineering as it deals with the latest research findings and their practical implementations, as well as new formulations and solutions.

Probabilistic performance-based seismic design CRC Press

A brief summary of the history of seismic design as given in chapter 1, indicates that initially design was purely based on strength or force considerations. When the importance of displacement, however,

became better appreciated, it was attempted to modify the existing force-based approach in order to include considerations of displacement, rather than to totally reconsider the procedure on a more rational basis. In the last decade, then, several researchers started pointing out this inconsistency, proposing displacement-based approaches for earthquake engineering evaluation and design, with the aim of providing improved reliability in the engineering process by more directly relating computed response and expected structural performance. The main objective of this report is to summarize, critically review and compare the displacement - based approaches proposed in the literature, thus favouring code implementation and practical use of rational and reliable methods. Chapter 2 Seismic performance and design objectives of this report introduces concepts of performance levels, seismic hazard representation , and the coupling of performance and hazard to define performance objectives. In fact, for displacement analysis to be relevant in the context of performance-based design, the structural

engineer must select appropriate performance levels and seismic loadings. A critical review of some engineering limit states appropriate to the different performance levels is therefore proposed. In chapter 3 Conceptual basis for displacement-based earthquake resistant design, the fundamental principles associated with displacement of the ground during an earthquake and the effects, in terms of displacement, in the structure, are reviewed. The historical development guides the presentation with a review of general linear and nonlinear structural dynamics principles, general approaches to estimate displacement, for both ground and structure, and finally a general presentation of the means to measure and judge the appropriateness of the displacements of the structure in section. Chapter 4 Approaches and procedures for displacement-based design can be somehow considered the fundamental part of the report, since a critical summary of the displacement - based approaches proposed by different researchers is presented there. Displacement - based design

may require specific characterization of the input ground motion, a topic addressed in Chapter 5 Seismic input. In general, various pertinent definitions of input motion for non-code format analysis are included, while peak ground parameters necessary for code base shear equations are only addressed as needed for the definition of motion for analysis. Chapter 6 Displacement capacity of members and systems addresses the fundamental problem of evaluating the inelastic displacement capacity of reinforced concrete members and realistic values of their effective cracked stiffness at yielding, including effects of shear and inclined cracking, anchorage slip, bar buckling and of load cycling. In Chapter 7 Application and evaluation of displacement-based approaches, some of the many different displacement based design procedures briefly introduced in Chapter 4 are applied to various case studies, identifying and discussing the difficulties a designer may encounter when trying to use displacement based design. Results for five different case studies designed in accordance

with eight different displacement based design methods are presented. Although in general case studies are considered a useful but marginal part of a state of the art document, in this case it has to be noted that chapter 7 is possibly the most innovative and fundamental part of the whole report. The conclusions of chapter 7 are the fundamental and essential conclusions of the document and allow foreseeing a bright future for displacement - based design approaches. The state-of-art report has been elaborated over a period of 4 years by Task Group 7.2 Displacement-based design and assessment of fib Commission 7Seismic design, a truly international team of experts, representing the expertise and experience of all the important seismic regions of the world. In October 2002 the final draft of the Bulletin was presented to the public during the 1st fibCongress in Osaka. It was also there that it was approved by fib Commission 7Seismic Design.

Formulations and Applications

Springer Science & Business Media

"The purpose of this book is to advance the wind design of tall buildings,

enabling the performance-based design, review, acceptance, and construction of buildings using analyses, materials, structural systems, and devices that may or may not be covered by the prescriptive provisions of today's building codes"--

Advances in Performance-Based Earthquake Engineering

IGI Global

This book aims to serve as an essential reference to facilitate civil engineers involved in the design of new conventional (ordinary) reinforced concrete (R/C) buildings regulatedby the current European EC8 (EN 1998-1:2004) and EC2 (EN 1992-1-1:2004) codesof practice. The book provides unique step-by-step flowcharts which take the readerthrough all the required operations, calculations, and verification checks prescribed bythe EC8 provisions. These flowcharts are complemented by comprehensive discussionsand practical explanatory comments on critical aspects of the EC8 code-regulatedprocedure for the earthquake resistant design of R/C buildings. Further, detailedanalysis and design examples of typical multi-storey three-dimensional R/C buildingsare

included to illustrate the required steps for achieving designs of real-life structures which comply with the current EC8 provisions. These examples can be readily used as verification tutorials to check the reliability of custom-made computer programs and of commercial Finite Element software developed/used for the design of earthquakeresistant R/C buildings complying with the EC8 (EN 1998-1:2004) code.This book will be of interest to practitioners working in consulting and designingengineering companies and to advanced undergraduate and postgraduate level civilengineering students attending courses and curricula in the earthquake resistant designof structures and/or undertaking pertinent design projects.

Select Proceedings of ICRDSI 2019

Performance Based Seismic Design for Tall BuildingsAn Output of the CTBUH Performance Based Seismic Design Working GroupPerformance-Based Seismic Design (PBSD) is a structural design methodology that has become more common in urban centers around the world, particularly for the design of high-rise buildings. The

primary benefit of PBSD is that it substantiates exceptions to prescribed code requirements, such as height limits applied to specific structural systems, and allows project teams to demonstrate higher performance levels for structures during a seismic event.However, the methodology also involves significantly more effort in the analysis and design stages, with verification of building performance required at multiple seismic demand levels using Nonlinear Response History Analysis (NRHA). The design process also requires substantial knowledge of overall building performance and analytical modeling, in order to proportion and detail structural systems to meet specific performance objectives.This CTBUH Technical Guide provides structural engineers, developers, and contractors with a general understanding of the PBSD process by presenting case studies that demonstrate the issues commonly encountered when using the methodology, along with their corresponding solutions. The guide also provides references to the latest industry guidelines, as applied in the

western United States, with the goal of disseminating these methods to an international audience for the advancement and expansion of PBSD principles worldwide.Performance-Based Seismic Design of Concrete Structures and Infrastructures Following the great progress made in computing technology, both in computer and programming technology, computation has become one of the most powerful tools for researchers and practicing engineers. It has led to tremendous achievements in computer-based structural engineering and there is evidence that current develments will even accelerate in the near future. To acknowledge this trend, Tongji University, Vienna University of Technology, and Chinese Academy of Engine- ing, co-organized the International Symposium on Computational Structural En- neering 2009 in Shanghai (CSE'09). CSE'09 aimed at providing a forum for presentation and discussion of sta- of-the-art development in scientific computing applied to engineering sciences. Emphasis was given to basic methodologies , scientific development and engine- ing applications. Therefore, it became a central

academic activity of the Inter- tional Association for Computational Mechanics (IACM), the European Com- nity on Computational Methods in Applied Sciences (ECCOMAS), The Chinese Society of Theoretical and Applied Mechanic, the China Civil Engineering So- ety, and the Architectural Society of China. A total of 10 invited papers, and around 140 contributed papers were p- sented in the proceedings of the symposium. Contributors of papers came from 20 countries around the world and covered a wide spectrum related to the compu- tional structural engineering.