



# SEISMIC DESIGN OF REINFORCED AND PRECAST CONCRETE BUILDINGS

ROBERT E. ENGLEKIRK

# Seismic Design Of Reinforced And Precast Concrete Buildings

**FIB - International Federation for  
Structural Concrete**



## **Seismic Design Of Reinforced And Precast Concrete Buildings:**

**Seismic Design of Reinforced and Precast Concrete Buildings** Englekirk, P. C. Jordan, 2003-02-01      **Seismic Design of Reinforced and Precast Concrete Buildings** Robert E. Englekirk, 2003-03-10 Presents the basics of seismic resistant design of concrete structures Provides a major focus on the seismic design of precast bracing systems      **Seismic Design of Reinforced and Precast Concrete Buildings** Robert E. Englekirk, 2003-03-10 Presents the basics of seismic resistant design of concrete structures Provides a major focus on the seismic design of precast bracing systems      **Seismic Design of Precast Concrete Building Structures** fib Fédération internationale du béton, 2003-01-01 The aim of this state of art report is to present current practices for use of precast and prestressed concrete in countries in seismic regions to recommend good practice and to discuss current developments The report has been drafted by 30 contributors from nine different countries This state of art report covers state of the practice in various countries advantages and disadvantages of incorporating precast reinforced and prestressed concrete in construction lessons learned from previous earthquakes construction concepts design approaches primary lateral load resisting systems precast and prestressed concrete frame systems and structural walls including dual systems diaphragms of precast and prestressed concrete floor units modelling and analytical methods gravity load resisting systems foundations and miscellaneous elements shells folded plates stairs and architectural cladding panels Design equations are reported where necessary but the emphasis is on principles Ordinary cast in place reinforced concrete is not considered in this report This fib state of the art report is intended to assist designers and constructors to provide safe and economical applications of structural precast concrete and at the same time to allow innovation in design and construction to continue This Bulletin N 27 was approved as an fib state of art report in autumn 2002 by fib Commission 7 Seismic design      **Precast-concrete buildings in seismic areas** FIB - Féd. Int. du Béton, 2016 This document has a broad scope and is not focussed on design issues Precast construction under seismic conditions is treated as a whole The main principles of seismic design of different structural systems their behavior and their construction techniques are presented through rules construction steps and sequences procedures and details that should lead to precast structures built in seismic areas complying with the fundamental performance requirements of collapse prevention and life safety in major earthquakes and limited damage in more frequent earthquakes The content of this document is largely limited to conventional precast construction and although some information is provided on the well known PRESSS technology jointed ductile dry connections this latter solution is not treated in detail in this document The general overview contained in this document of alternative structural systems and connection solutions available to achieve desired performance levels intends to provide engineers architects clients and end users in general with a better appreciation of the wide range of applications that modern precast concrete technology can have in various types of construction from industrial to commercial as well as residential Lastly the emphasis on practical aspects from conceptual design to connection detailing aims to help

engineers to move away from the habit of blindly following prescriptive codes in their design but instead go back to basic principles in order to achieve a more robust understanding and thus control of the seismic behaviour of the structural system as a whole as well as of its components and individual connections

**Design of Connections for Precast Prestressed Concrete Buildings for the Effects of Earthquake** D. P. Clough, 1986

**Displacement-based Seismic Design of Reinforced Concrete Buildings** fib Fédération internationale du béton, 2003

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

**EARTHQUAKE RESISTANT DESIGN OF STRUCTURES** AGRAWAL, PANKAJ ,SHRIKHANDE, MANISH ,2006-01-01 This comprehensive and well organized book presents the concepts and principles of earthquake resistant design of structures in an easy to read style The use of these principles helps in the implementation of seismic design practice The book adopts a step by step approach starting from the fundamentals of structural dynamics to application of seismic codes in analysis and design of structures The text also focusses on seismic evaluation and retrofitting of reinforced concrete and masonry buildings The text has been enriched with a large number of diagrams and solved problems to reinforce the understanding of the concepts Intended mainly as a text for undergraduate and postgraduate students of civil engineering this text would also be of considerable benefit to practising engineers architects field engineers and teachers in the field of earthquake resistant design of structures

**Guide to Emulating Cast-in-Place Detailing for Seismic Design of Precast Concrete Structures** Joint ACI-ASCE Committee 550,American Concrete Institute,2009 This guide provides information for detailing precast concrete structures that should meet building code requirements for all seismic design categories by emulating cast in place reinforced concrete design This guide also explains how emulative precast concrete structures can address the provisions of ACI 318 08 including those of Chapter 21 if special attention is directed to detailing the joints and splices between precast components

**Seismic Design of Reinforced Concrete Buildings** Jack Moehle,2014-10-06 Complete coverage of earthquake resistant concrete building design Written by a renowned seismic engineering expert this authoritative resource discusses the theory and practice for the design and evaluation of earthquakeresisting reinforced concrete buildings The book addresses the behavior of reinforced concrete materials components and systems subjected to routine and extreme loads with an emphasis on response to earthquake loading Design methods both at a basic level as required by current building codes and at an advanced level needed for special problems such as seismic performance assessment are described Data and models useful

for analyzing reinforced concrete structures as well as numerous illustrations tables and equations are included in this detailed reference Seismic Design of Reinforced Concrete Buildings covers Seismic design and performance verification Steel reinforcement Concrete Confined concrete Axially loaded members Moment and axial force Shear in beams columns and walls Development and anchorage Beam column connections Slab column and slab wall connections Seismic design overview Special moment frames Special structural walls Gravity framing Diaphragms and collectors Foundations

**Design of Reinforced Concrete Buildings for Seismic Performance** Mark Aschheim, Enrique

Hernández-Montes, Dimitrios Vamvatsikos, 2019-04-05 The costs of inadequate earthquake engineering are huge especially for reinforced concrete buildings This book presents the principles of earthquake resistant structural engineering and uses the latest tools and techniques to give practical design guidance to address single or multiple seismic performance levels It presents an elegant simple and theoretically coherent design framework Required strength is determined on the basis of an estimated yield displacement and desired limits of system ductility and drift demands A simple deterministic approach is presented along with its elaboration into a probabilistic treatment that allows for design to limit annual probabilities of failure The design method allows the seismic force resisting system to be designed on the basis of elastic analysis results while nonlinear analysis is used for performance verification Detailing requirements of ACI 318 and Eurocode 8 are presented Students will benefit from the coverage of seismology structural dynamics reinforced concrete and capacity design approaches which allows the book to be used as a foundation text in earthquake engineering

**Structural Concrete, Volume 1** fib Fédération internationale du béton, 2009-01-01 **Proceedings fib Symposium in Athens Greece FIB - International Federation for Structural Concrete, 2003-05-01** **Fibre Reinforced Concrete: From Design to Structural Applications** FIB - International Federation for Structural Concrete, 2020-08-01

The first international FRC workshop supported by RILEM and ACI was held in Bergamo Italy in 2004 At that time a lack of specific building codes and standards was identified as the main inhibitor to the application of this technology in engineering practice The workshop aim was placed on the identification of applications guidelines and research needs in order for this advanced technology to be transferred to professional practice The second international FRC workshop held in Montreal Canada in 2014 was the first ACI fib joint technical event Many of the objectives identified in 2004 had been achieved by various groups of researchers who shared a common interest in extending the application of FRC materials into the realm of structural engineering and design The aim of the workshop was to provide the State of the Art on the recent progress that had been made in term of specifications and actual applications for buildings underground structures and bridge projects worldwide The rapid development of codes the introduction of new materials and the growing interest of the construction industry suggested presenting this forum at closer intervals In this context the third international FRC workshop was held in Desenzano Italy four years after Montreal In this first ACI fib RILEM joint technical event the maturity gained through the recent

technological developments and large scale applications were used to show the acceptability of the concrete design using various fibre compositions The growing interests of civil infrastructure owners in ultra high performance fibre reinforced concrete UHPFRC and synthetic fibres in structural applications bring new challenges in terms of concrete technology and design recommendations In such a short period of time we have witnessed the proliferation of the use of fibres as structural reinforcement in various applications such as industrial floors elevated slabs precast tunnel lining sections foundations as well as bridge decks We are now moving towards addressing many durability based design requirements by the use of fibres as well as the general serviceability based design However the possibility of having a residual tensile strength after cracking of the concrete matrix requires a new conceptual approach for a proper design of FRC structural elements With such a perspective in mind the aim of FRC2018 workshop was to provide the State of the Art on the recent progress in terms of specifications development actual applications and to expose users and researchers to the challenges in the design and construction of a wide variety of structural applications Considering that at the time of the first workshop in 2004 no structural codes were available on FRC we have to recognize the enormous work done by researchers all over the world who have presented at many FRC events and convinced code bodies to include FRC among the reliable alternatives for structural applications This will allow engineers to increasingly utilize FRC with confidence for designing safe and durable structures Many presentations also clearly showed that FRC is a promising material for efficient rehabilitation of existing infrastructure in a broad spectrum of repair applications These cases range from sustained gravity loads to harsh environmental conditions and seismic applications which are some of the broadest ranges of applications in Civil Engineering The workshop was attended by researchers designers owner and government representatives as well as participants from the construction and fibre industries The presence of people with different expertise provided a unique opportunity to share knowledge and promote collaborative efforts These interactions are essential for the common goal of making better and sustainable constructions in the near future The workshop was attended by about 150 participants coming from 30 countries Researchers from all the continents participated in the workshop including 24 Ph D students who brought their enthusiasm in FRC structural applications For this reason the workshop Co chairs sincerely thank all the enterprises that sponsored this event They also extend their appreciation for the support provided by the industry over the last 30 years which allowed research centers to study FRC materials and their properties and develop applications to making its use more routine and accepted throughout the world Their important contribution has been essential for moving the knowledge base forward Finally we appreciate the enormous support received from all three sponsoring organizations of ACI fib and Rilem and look forward to paving the path for future collaborations in various areas of common interest so that the developmental work and implementation of new specifications and design procedures can be expedited internationally

*Structural Concrete, Volume 2* fib Fédération internationale du béton, 2010-01-01 The second edition of the Structural Concrete Textbook is an

extensive revision that reflects advances in knowledge and technology over the past decade. It was prepared in the intermediate period from the CEP FIP Model Code 1990 MC90 to fib Model Code 2010 MC2010 and as such incorporates a significant amount of information that has been already finalized for MC2010 while keeping some material from MC90 that was not yet modified considerably. The objective of the Textbook is to give detailed information on a wide range of concrete engineering from selection of appropriate structural system and also materials through design and execution and finally behaviour in use. The revised fib Structural Concrete Textbook covers the following main topics: phases of design process, conceptual design, short and long term properties of conventional concrete including creep, shrinkage, fatigue and temperature influences, special types of concretes such as self-compacting concrete, architectural concrete, fibre reinforced concrete, high and ultra high performance concrete, properties of reinforcing and prestressing materials, bond, tension stiffening, moment curvature, confining effect, dowel action, aggregate interlock, structural analysis with or without time dependent effects, definition of limit states, control of cracking and deformations, design for moment, shear or torsion, buckling, fatigue, anchorages, splices, detailing, design for durability including service life, design aspects, deterioration mechanisms, modelling of deterioration mechanisms, environmental influences, influences of design and execution on durability, fire design including changes in material and structural properties, spalling, degree of deterioration, member design, linear members and slabs with reinforcement layout, deep beams, management, assessment, maintenance, repair including conservation strategies, risk management, types of interventions as well as aspects of execution, quality assurance, formwork and curing. The updated Textbook provides the basics of material and structural behaviour and the fundamental knowledge needed for the design, assessment or retrofitting of concrete structures. It will be essential reading material for graduate students in the field of structural concrete and also assist designers and consultants in understanding the background to the rules they apply in their practice. Furthermore, it should prove particularly valuable to users of the new editions of Eurocode 2 for concrete buildings, bridges and container structures which are based only partly on MC90 and partly on more recent knowledge which was not included in the 1999 edition of the Textbook.

*Fibre-reinforced concrete: From design to structural applications*  
FIB - Féd. Int. du Béton, 2016

The FRC 2014 Workshop: Fibre Reinforced Concrete from Design to Structural Applications was the first ACI fib joint technical event. The Workshop held at Polytechnique Montreal, Canada, on July 24th and 25th, 2014, was attended by 116 participants from 25 countries and 4 continents. The first international FRC workshop was held in Bergamo, Italy, in 2004. At that time, the lack of specific building codes and standards was identified as the main inhibitor to the application of this technology in engineering practice. Ten years after Bergamo, many of the objectives identified at that time have been achieved. The use of fibre reinforced concrete (FRC) for designing structural members in bending and shear has recently been addressed in the fib Model Code 2010. Steel fibre reinforced concrete (SFRC) has also been used structurally in several building and bridge projects in Europe and North America. SFRC has been widely used in segmental tunnel linings, all



over the world Members of ACI544 and fib TG 4 1 have been involved in writing code based specifications for the design of FRC structural members More than fifty papers were presented at the Workshop from which forty four were selected for this joint ACI fib publication The papers are organised in the document under six themes Design guidelines and specifications Material properties for design Behaviour and design of beams and columns Behaviour and design of slabs and other structures Behaviour and design of foundations and underground components and finally Applications in structure and underground construction projects Structural Concrete Textbook, Volume 4 fib Fédération internationale du béton,2010-06-01 The second edition of the Structural Concrete Textbook is an extensive revision that reflects advances in knowledge and technology over the past decade It was prepared in the intermediate period from the CEP FIP Model Code 1990 MC90 to fib Model Code for Concrete Structures 2010 MC2010 and as such incorporates a significant amount of information that has been already finalized for MC2010 while keeping some material from MC90 that was not yet modified considerably The objective of the textbook is to give detailed information on a wide range of concrete engineering from selection of appropriate structural system and also materials through design and execution and finally behaviour in use The revised fib Structural Concrete Textbook covers the following main topics phases of design process conceptual design short and long term properties of conventional concrete including creep shrinkage fatigue and temperature influences special types of concretes such as self compacting concrete architectural concrete fibre reinforced concrete high and ultra high performance concrete properties of reinforcing and prestressing materials bond tension stiffening moment curvature confining effect dowel action aggregate interlock structural analysis with or without time dependent effects definition of limit states control of cracking and deformations design for moment shear or torsion buckling fatigue anchorages splices detailing design for durability including service life design aspects deterioration mechanisms modelling of deterioration mechanisms environmental influences influences of design and execution on durability fire design including changes in material and structural properties spalling degree of deterioration member design linear members and slabs with reinforcement layout deep beams management assessment maintenance repair including conservation strategies risk management types of interventions as well as aspects of execution quality assurance formwork and curing The updated textbook provides the basics of material and structural behaviour and the fundamental knowledge needed for the design assessment or retrofitting of concrete structures It will be essential reading material for graduate students in the field of structural concrete and also assist designers and consultants in understanding the background to the rules they apply in their practice Furthermore it should prove particularly valuable to users of the new editions of Eurocode 2 for concrete buildings bridges and container structures which are based only partly on MC90 and partly on more recent knowledge which was not included in the 1999 edition of the textbook Construction Materials and Computer Engineering II Wen Song Hu,2013-07-31 Selected peer reviewed papers from the 2013 2nd International Conference on Sustainable Construction Materials and Computer

Engineering ICSCMCE 2013 June 1 2 2013 Singapore      **3rd fib Congress Washington USA** FIB - International  
Federation for Structural Concrete, 2010-06-01      **Seismic Performance of Concrete Buildings** Liviu Crainic, Mihai  
Munteanu, 2012-12-10 This book examines and presents essential aspects of the behavior analysis design and detailing of  
reinforced concrete buildings subjected to strong seismic activity Seismic design is an extremely complex problem that has  
seen spectacular development in the last decades The present volume tries to show how the principles and methods of  
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## **Table of Contents Seismic Design Of Reinforced And Precast Concrete Buildings**

1. Understanding the eBook Seismic Design Of Reinforced And Precast Concrete Buildings
  - The Rise of Digital Reading Seismic Design Of Reinforced And Precast Concrete Buildings
  - Advantages of eBooks Over Traditional Books
2. Identifying Seismic Design Of Reinforced And Precast Concrete Buildings
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Seismic Design Of Reinforced And Precast Concrete Buildings
  - User-Friendly Interface
4. Exploring eBook Recommendations from Seismic Design Of Reinforced And Precast Concrete Buildings
  - Personalized Recommendations
  - Seismic Design Of Reinforced And Precast Concrete Buildings User Reviews and Ratings
  - Seismic Design Of Reinforced And Precast Concrete Buildings and Bestseller Lists
5. Accessing Seismic Design Of Reinforced And Precast Concrete Buildings Free and Paid eBooks
  - Seismic Design Of Reinforced And Precast Concrete Buildings Public Domain eBooks
  - Seismic Design Of Reinforced And Precast Concrete Buildings eBook Subscription Services
  - Seismic Design Of Reinforced And Precast Concrete Buildings Budget-Friendly Options

6. Navigating Seismic Design Of Reinforced And Precast Concrete Buildings eBook Formats
  - ePub, PDF, MOBI, and More
  - Seismic Design Of Reinforced And Precast Concrete Buildings Compatibility with Devices
  - Seismic Design Of Reinforced And Precast Concrete Buildings Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Seismic Design Of Reinforced And Precast Concrete Buildings
  - Highlighting and Note-Taking Seismic Design Of Reinforced And Precast Concrete Buildings
  - Interactive Elements Seismic Design Of Reinforced And Precast Concrete Buildings
8. Staying Engaged with Seismic Design Of Reinforced And Precast Concrete Buildings
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Seismic Design Of Reinforced And Precast Concrete Buildings
9. Balancing eBooks and Physical Books Seismic Design Of Reinforced And Precast Concrete Buildings
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Seismic Design Of Reinforced And Precast Concrete Buildings
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Seismic Design Of Reinforced And Precast Concrete Buildings
  - Setting Reading Goals Seismic Design Of Reinforced And Precast Concrete Buildings
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Seismic Design Of Reinforced And Precast Concrete Buildings
  - Fact-Checking eBook Content of Seismic Design Of Reinforced And Precast Concrete Buildings
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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