

Seismic Retrofit of Existing Reinforced Concrete Buildings

Stelios Antoniou



WILEY Blackwell

Design Of Seismic Retrofitting Of Reinforced Concrete

Jeffrey Ger, Franklin Y. Cheng



Design Of Seismic Retrofitting Of Reinforced Concrete:

Seismic Assessment and Retrofit of Reinforced Concrete Buildings fib Fédération internationale du béton, 2003-08-01 In most parts of the developed world the building stock and the civil infrastructure are ageing and in constant need of maintenance repair and upgrading. Moreover in the light of our current knowledge and of modern codes the majority of buildings stock and other types of structures in many parts of the world are substandard and deficient. This is especially so in earthquake prone regions as even there seismic design of structures is relatively recent. In those regions the major part of the seismic threat to human life and property comes from old buildings. Due to the infrastructure's increasing decay frequently combined with the need for structural upgrading to meet more stringent design requirements especially against seismic loads structural retrofitting is becoming more and more important and receives today considerable emphasis throughout the world. In response to this need a major part of the fib Model Code 2005 currently under development is being devoted to structural conservation and maintenance. More importantly in recognition of the importance of the seismic threat arising from existing substandard buildings the first standards for structural upgrading to be promoted by the international engineering community and by regulatory authorities alike are for seismic rehabilitation of buildings. This is the case for example of Part 3 Strengthening and Repair of Buildings of Eurocode 8 i.e. of the draft European Standard for earthquake resistant design and which is the only one among the current 2003 set of 58 Eurocodes attempting to address the problem of structural upgrading. It is also the case of the recent 2001 ASCE draft standard on Seismic evaluation of existing buildings and of the 1996 Law for promotion of seismic strengthening of existing reinforced concrete structures in Japan. As noted in Chapter 1 of this Bulletin fib as CEB and FIP did before has placed considerable emphasis on assessment and rehabilitation of existing structures. The present Bulletin is a culmination of this effort in the special but very important field of seismic assessment and rehabilitation. It has been elaborated over a period of 4 years by Task Group 7.1 Assessment and retrofit of existing structures of fib Commission 7. Seismic design a truly international team of experts representing the expertise and experience of all the important seismic regions of the world. In the course of its work the team had six plenary two day meetings in January 1999 in Pavia Italy in August 1999 in Raleigh North Carolina in February 2000 in Queenstown New Zealand in July 2000 in Patras Greece in March 2001 in Lausanne Switzerland and in August 2001 in Seattle Washington. In October 2002 the final draft of the Bulletin was presented to public during the 1st fib Congress in Osaka. It was also there that it was approved by fib Commission 7 Seismic Design. The contents is structured into main chapters as follows: 1 Introduction 2 Performance objectives and system considerations 3 Review of seismic assessment procedures 4 Strength and deformation capacity of non seismically detailed components 5 Seismic retrofitting techniques 6 Probabilistic concepts and methods 7 Case studies

Retrofitting of Heritage Structures S. Syngellakis, 2013 The preservation of heritage architecture is a cultural objective rigorously pursued by communities and nations wishing to promote their history civilisation and

aesthetic achievements Structures built in the remote past by traditional methods have suffered the consequences of extreme loading events such as earthquakes over long time periods Retrofitting is an approach based on recent technological developments and scientific knowledge whereby modern construction methods and materials are applied to the repair and strengthening of historical structures This book aims to inform on current retrofitting techniques their application to various types of historical architecture and their effectiveness to fulfil their purpose Retrofitted structural forms covered in the book vary widely from age old places of worship such as churches mosques and temples as well as castles and palaces to more modern distinguished private residences or public buildings some of them designed by well known architects Their methods of construction range from traditional such as stone or brick masonry to more recent textile block systems and even reinforced concrete frameworks Reference is made to detailed visual inspections of damaged structure providing valuable insight into possible causes of failure such inspections are usually combined with material characterisation which is an essential input to numerical modelling for assessing the behaviour of the structure before and after retrofitting The book describes strengthening techniques for masonry walls including re pointing injection grouting and the use of steel ties The use of reinforced concrete is proposed in the form of cast in place walls jackets or tie beams that of carbon fibre reinforced laminates for strengthening walls and slabs Innovative use of materials such as shape memory alloys self compacting concrete or thin lead layers is also suggested Particular attention is given to methods for moderating the consequences of destructive earthquakes Seismic energy absorbing devices and base isolation systems are two effective means of providing protection against future seismic events although their application is often met with many technical challenges in practice Retrofitting of Heritage Structures Against Earthquakes will be of interest to members of academic institutions government or private cultural preservation establishments and specialist consultant engineers The book contains very practical technical advice on many issues this would be of considerable interest to construction companies specialising in repairs and maintenance of historical structures

Seismic Design, Assessment and Retrofitting of Concrete Buildings Michael N. Fardis, 2009-07-25 Reflecting the historic first European seismic code this professional book focuses on seismic design assessment and retrofitting of concrete buildings with thorough reference to and application of EN Eurocode 8 Following the publication of EN Eurocode 8 in 2004 05 30 countries are now introducing this European standard for seismic design for application in parallel with existing national standards till March 2010 and exclusively after that Eurocode 8 is also expected to influence standards in countries outside Europe or at the least to be applied there for important facilities Owing to the increasing awareness of the threat posed by existing buildings substandard and deficient buildings and the lack of national or international standards for assessment and retrofitting its impact in that field is expected to be major Written by the lead person in the development of the EN Eurocode 8 the present handbook explains the principles and rationale of seismic design according to modern codes and provides thorough guidance for the conceptual seismic design of concrete buildings

and their foundations It examines the experimental behaviour of concrete members under cyclic loading and modelling for design and analysis purposes it develops the essentials of linear or nonlinear seismic analysis for the purposes of design assessment and retrofitting especially using Eurocode 8 and gives detailed guidance for modelling concrete buildings at the member and at the system level Moreover readers gain access to overviews of provisions of Eurocode 8 plus an understanding for them on the basis of the simple models of the element behaviour presented in the book Also examined are the modern trends in performance and displacement based seismic assessment of existing buildings comparing the relevant provisions of Eurocode 8 with those of new US prestandards and details of the most common and popular seismic retrofitting techniques for concrete buildings and guidance for retrofitting strategies at the system level Comprehensive walk through examples of detailed design elucidate the application of Eurocode 8 to common situations in practical design Examples and case studies of seismic assessment and retrofitting of a few real buildings are also presented From the reviews This is a massive book that has no equal in the published literature as far as the reviewer knows It is dense and comprehensive and leaves nothing to chance It is certainly taxing on the reader and the potential user but without it use of Eurocode 8 will be that much more difficult In short this is a must read book for researchers and practitioners in Europe and of use to readers outside of Europe too This book will remain an indispensable backup to Eurocode 8 and its existing Designers Guide to EN 1998 1 and EN 1998 5 published in 2005 for many years to come Congratulations to the author for a very well planned scope and contents and for a flawless execution of the plan

AMR S ELNASHAI The book is an impressive source of information to understand the response of reinforced concrete buildings under seismic loads with the ultimate goal of presenting and explaining the state of the art of seismic design Underlying the contents of the book is the in depth knowledge of the author in this field and in particular his extremely important contribution to the development of the European Design Standard EN 1998 Eurocode 8 Design of structures for earthquake resistance However although Eurocode 8 is at the core of the book many comparisons are made to other design practices namely from the US and from Japan thus enriching the contents and interest of the book

EDUARDO C CARVALHO Strengthening and Retrofitting of Existing Structures, 2018-05

Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity ground motion or soil failure due to earthquakes The planning of changes to existing buildings differs from new planning through an important condition the existing construction must be taken as the basis of all planning and building actions The need for seismic retrofitting of an existing building can arise due to several reasons like building not designed to code subsequent updating of code and design practice subsequent upgrading of seismic zone deterioration of strength and aging modification of existing structure change in use of the building etc Seismic retrofit is primarily applied to achieve public safety with various levels of structure and material survivability determined by economic considerations In recent years an increased urgency has been felt to strengthen the deficient buildings as part of active disaster mitigation and to work out the modifications that may be

made to an existing structure to improve the structural performance during an earthquake Seismic retrofitting schemes can be either global or local based on how many members of the structures they are used for Global Retrofit methods include conventional methods increase seismic resistance of existing structures or non conventional methods reduction of seismic demand Strengthening and Retrofitting of Existing Structures is a compendium of cutting edge trends of the research and existing practices in strengthening and retrofitting of structural elements as well as the findings of a research endeavor initiated by the authors to investigate and develop a robust structural retrofitting scheme by utilizing elastomeric polymers to enhance the resistance of reinforced concrete RC structures It addresses in detail specific techniques for the strengthening of traditional constructions reinforced concrete buildings bridges and their foundations It also presents insight into the key issues relevant to seismic retrofit of concrete frame buildings Many guidelines are reviewed regarding seismic rehabilitation of school office hospital and apartment buildings

Seismic Retrofit of Existing Reinforced Concrete Buildings Stelios Antoniou, 2023-02-28 Seismic Retrofit of Existing Reinforced Concrete Buildings Understand the complexities and challenges of retrofitting building infrastructure Across the world buildings are gradually becoming structurally unsound Many were constructed before seismic load capacity was a mandatory component of building standards and were often built with low quality materials or using unsafe construction practices Many more are simply aging with materials degrading and steel corroding As a result efforts are ongoing to retrofit existing structures and to develop new techniques for assessing and enhancing seismic load capacity in order to create a safer building infrastructure worldwide Seismic Retrofit of Existing Reinforced Concrete Buildings provides a thorough book length discussion of these techniques and their applications Balancing theory and practice the book provides engineers with a broad base of knowledge from which to approach real world seismic assessments and retrofitting projects It incorporates knowledge and experience frequently omitted from the building design process for a fuller account of this critical engineering subfield Seismic Retrofit of Existing Reinforced Concrete Buildings readers will also find Detailed treatment of each available strengthening technique complete with advantages and disadvantages In depth guidelines to select a specific technique for a given building type and or engineering scenario Step by step guidance through the assessment retrofitting process Seismic Retrofit of Existing Reinforced Concrete Buildings is an ideal reference for civil and structural engineering professionals and advanced students particularly those working in seismically active areas

Retrofitting of Concrete Structures by Externally Bonded FRPs, With Emphasis on Seismic Applications fib Fédération internationale du béton, 2006-01-01 fib Bulletin 35 is the first bulletin to publish documentation from an fib short course These courses are held worldwide and cover advanced knowledge of structural concrete in general or specific topics They are organized by fib and given by internationally recognized experts in fib often supplemented with local experts active in fib They are based on the knowledge and expertise from fib s ten Commissions and nearly fifty Task Groups fib Bulletin 35 presents the course materials developed for the short course Retrofitting of Concrete

Structures through Externally Bonded FRP with emphasis on Seismic Applications given in Ankara and Istanbul in June 2005. The course drew on expertise both from outside Turkey and from the large pool of local experts on this subject. In most countries of the world the building stock is ageing and needs continuous maintenance or repair. Moreover the majority of existing constructions are deficient in the light of current knowledge and design codes. The problem of structural deficiency of existing constructions is especially acute in seismic regions as even there seismic design of structures is relatively recent. The direct and indirect costs of demolition and reconstruction of structurally deficient constructions are often prohibitive; furthermore they entail a substantial waste of natural resources and energy. Therefore structural retrofitting is becoming increasingly widespread throughout the world. Externally bonded Fibre Reinforced Polymers (FRPs) are rapidly becoming the technique of choice for structural retrofitting. They are cleaner and easier to apply than conventional retrofitting techniques, reduce disruption to the occupancy and operation of the facility, do not generate debris or waste and reduce health and accident hazards at the construction site as well as noise and air pollution in the surroundings. fib Bulletin 35 gives state of the art coverage of retrofitting through FRPs and presents relevant provisions from three recent standardisation milestones: EN 1998-3:2005 Eurocode 8 Design of structures for earthquake resistance Part 3 Assessment and retrofitting of buildings; the 2005 Draft of the Turkish seismic design code and the Italian regulatory document CNR DT 200/04 Instructions for Design, Execution and Control of Strengthening Interventions by Means of Fibre Reinforced Composites (2004).

Computer Aided Seismic and Fire Retrofitting Analysis of Existing High Rise Reinforced Concrete Buildings Raja Rizwan Hussain, Muhammad Wasim, Saeed Hasan, 2015-08-13. This book details the analysis and design of high rise buildings for gravity and seismic analysis. It provides the knowledge structural engineers need to retrofit existing structures in order to meet safety requirements and better prevent potential damage from such disasters as earthquakes and fires. Coverage includes actual case studies of existing buildings, reviews of current knowledge for damages and their mitigation, protective design technologies and analytical and computational techniques. This monograph also provides an experimental investigation on the properties of fiber reinforced concrete that consists of natural fibres like coconut coir and also steel fibres that are used for comparison in both Normal Strength Concrete (NSC) and High Strength Concrete (HSC). In addition the authors examine the use of various repair techniques for damaged high rise buildings. The book will help upcoming structural design engineers learn the computer aided analysis and design of real existing high rise buildings by using ACI code for application of the gravity loads, UBC 97 for seismic analysis and retrofitting analysis by computer models. It will be of immense use to the student community, academicians, consultants and practicing professional engineers and scientists involved in the planning, design, execution, inspection and supervision for the proper retrofitting of buildings.

Guidelines for Seismic Retrofit of Existing Buildings, 2001. This renamed version of the former Uniform code for building conservation guidelines for retrofitting unreinforced masonry bearing wall buildings, reinforced concrete and reinforced masonry buildings.

wood frame residential buildings and concrete with masonry infill buildings *Fastenings for Seismic Retrofitting* Comité euro-international du béton,1997 The economic consequences and loss of life make earthquake disasters catastrophic anywhere in the world Seismic retrofitting or repair of buildings is an essential component for mitigating the effects of earthquakes This state of the art report reviews and introduces the latest design concepts and methods for seismic retrofitting throughout the world with emphasis on the use of fastening systems

Seismic Retrofit of Reinforced Concrete Frames with Diagonal Prestressing Cables Ali Molaei,2014 A large number of building inventory in Canada and elsewhere in the world consists of non ductile reinforced concrete frames with or without masonry infill panels These structures suffer damage when seismic force demands are higher than their force capacities Therefore seismic retrofitting of such frame buildings for drift control remains to be a viable option for improved building performance A retrofit methodology has been developed in the current research project which involves diagonal bracing of frames with prestressing strands An experimental research project has been conducted to assess the effectiveness of diagonal prestressing in non ductile reinforced concrete frame buildings The experimental program consists of two large scale single bay single storey reinforced concrete frames with a height of 3 0m and a span length of 3 5 m The frames were designed and built to reflect the 1960 s practice in Canada without the seismic requirements of current building codes and hence are seismically deficient They were retrofitted with diagonally placed prestressing strands having two different areas of steel prestressed to 40% of the strand capacity One of the frames was retested after the failure of the strands with a new set of strands without any prestressing forming the third test The results indicate that lateral bracing reinforced concrete frames with high strength prestressing strands is an effective strategy for controlling lateral drift and hence potential damage in buildings during strong earthquakes Prestressing of the strands increases initial stiffness as compared to non prestressed cables and provide superior performance The area of diagonally placed steel including the number of strands and the level of initial prestressing depend on the required level of upgrade in the building in terms of seismic force requirements The design procedure recommended in this thesis may be employed for implementing the technology The thesis presents the details of the experimental program and the test results It also provides analytical verification of the approach with a step by step design procedure

Seismic Design and Retrofitting of Reinforced Concrete Bridges G. Michele Calvi,M. J. N. Priestley,1991

Seismic Retrofit of Existing Reinforced Concrete Buildings Stelios Antoniou,2023-01-31 Seismic Retrofit of Existing Reinforced Concrete Buildings Understand the complexities and challenges of retrofitting building infrastructure Across the world buildings are gradually becoming structurally unsound Many were constructed before seismic load capacity was a mandatory component of building standards and were often built with low quality materials or using unsafe construction practices Many more are simply aging with materials degrading and steel corroding As a result efforts are ongoing to retrofit existing structures and to develop new techniques for assessing and enhancing seismic load capacity in order to create a

safer building infrastructure worldwide Seismic Retrofit of Existing Reinforced Concrete Buildings provides a thorough book length discussion of these techniques and their applications Balancing theory and practice the book provides engineers with a broad base of knowledge from which to approach real world seismic assessments and retrofitting projects It incorporates knowledge and experience frequently omitted from the building design process for a fuller account of this critical engineering subfield Seismic Retrofit of Existing Reinforced Concrete Buildings readers will also find Detailed treatment of each available strengthening technique complete with advantages and disadvantages In depth guidelines to select a specific technique for a given building type and or engineering scenario Step by step guidance through the assessment retrofitting process Seismic Retrofit of Existing Reinforced Concrete Buildings is an ideal reference for civil and structural engineering professionals and advanced students particularly those working in seismically active areas *Advanced Design Examples of Seismic Retrofit of Structures* Mohammad Yekrangnia,2018-09-13 *Advanced Design Examples of Seismic Retrofit of Structures* provides insights on the problems associated with the seismic retrofitting of existing structures The authors present various international case studies of seismic retrofitting projects and the different possible strategies on how to handle complex problems encountered Users will find tactics on a variety of problems that are commonly faced including problems faced by engineers and authorities who have little or no experience in the practice of seismic retrofitting Provides several examples of retrofitting projects that cover different structural systems from non engineered houses to frame buildings Presents various retrofitting methods through examples Provides detailed step by step design procedures for each example Includes real retrofit projects with photos of the details of various retrofitting techniques Contains several modeling details and hints making use of various software in this area **Seismic Retrofitting of Conventional Reinforced Concrete Moment-Resisting Frames Using Buckling Restrained Braces** Zaid Al-Sadoon,2016 [Handbook on Seismic Retrofit of Buildings](#) Amarnath Chakrabarti,Devdas Menon,Amlan Kumar Sengupta,2008 The Handbook on Seismic Retrofit of Buildings is a compiled source of technical information for engineers and professionals in the buildings industry decision making officials and students The Handbook is divided into 17 chapters covering basic concepts of earthquakes seismic design and retrofit of buildings seismic vulnerability assessment retrofit strategies for different types of buildings geotechnical and foundation aspects advanced applications quality assurance and case studies *Seismic Performance and Retrofitting of Reinforced Concrete Bridge Bents* ,2002 Summary available via the World Wide Web as of 8 29 2002 from the Bridge Research and Information Center web site **Seismic Design for Existing Structures** ,1986 [RC Structures Strengthened with FRP for Earthquake Resistance](#) Shamsher Bahadur Singh,C. V. R. Murty,2024-03-31 This book covers the merits and demerits of advanced composite materials with regard to their applications for earthquake resistant applications The chapters in the book are divided into the following main topics a the processing and fabrication of fiber reinforced polymer composite materials b the mechanical characteristics of materials c the design of strengthening and reinforcing

systems for earthquake resistance of the deficient structural system and design of new earthquake resistant structures using advanced composite materials. The chapters present experimental tests and numerical modeling of responses of various kinds of structural elements for predicting the load versus deflection response, energy absorption capacity, ductility index, energy ratios, failure modes, and load capacity. It also looks at different kinds of composite systems and their hybrid or functionally graded composites using advanced composite materials such as carbon fiber reinforced polymer (CFRP), glass fiber reinforced polymer (GFRP), aramid fiber reinforced polymer (AFRP), basalt fiber reinforced polymer (BFRP), and natural fiber reinforced polymer (NFRP). The results presented in this book will be of high interest to scientists, researchers, students, and engineers working in the fields of advanced composite materials such as FRPs and other forms of composites for seismic retrofitting and strengthening of deficient structures. This book is helpful for teachers and undergraduate, Master, and Ph.D. students to develop a fundamental understanding of the design of earthquake resistant structures such as buildings, bridges, and industrial structures using lightweight, durable, and sustainable FRP materials.

Seismic Design Aids for Nonlinear Pushover Analysis of Reinforced Concrete and Steel Bridges Jeffrey Ger, Franklin Y. Cheng, 2016-04-19. Nonlinear static monotonic pushover analysis has become a common practice in performance based bridge seismic design. The popularity of pushover analysis is due to its ability to identify the failure modes and the design limit states of bridge piers and to provide the progressive collapse sequence of damaged bridges when subjected to major earthquake.

Seismic Assessment and Retrofit of Bridges M. J. N. Priestley, Frieder Seible, 1991

Design Of Seismic Retrofitting Of Reinforced Concrete Book Review: Unveiling the Magic of Language

In an electronic digital era where connections and knowledge reign supreme, the enchanting power of language has become much more apparent than ever. Its power to stir emotions, provoke thought, and instigate transformation is actually remarkable. This extraordinary book, aptly titled "**Design Of Seismic Retrofitting Of Reinforced Concrete**," compiled by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we will delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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Design Of Seismic Retrofitting Of Reinforced Concrete Introduction

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