



# Seismic Assessment and Rehabilitation of Existing Buildings

Edited by

S. Tanvir Wasti and Guney Ozcebe

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# Seismic Assessment And Rehabilitation Of Existing Buildings

**Alper Ilki, Derya Çavunt, Yavuz Selim Çavunt**

## **Seismic Assessment And Rehabilitation Of Existing Buildings:**

**Seismic Assessment and Rehabilitation of Existing Buildings** S. Tanvir Wasti, Güney Özcebe, 2012-12-06 The present volume contains a total of 23 papers centred on the research area of Seismic Assessment and Rehabilitation of Existing Buildings This subject also forms the core of Project SfP977231 sponsored by the NATO Science for Peace Office and supported by the Scientific and Technical Research Council of Turkey TUBIT AK Most of these papers were presented by the authors at a NATO Science for Peace Workshop held in Izmir on 13 14 May 2003 and reflect a part of their latest work conducted within the general confines of the title of the NATO Project Middle East Technical University Ankara Turkey serves as the hub of Project SfP977231 and coordinates research under the project with universities within Turkey e g Istanbul Technical University and Kocaeli University and with partner institutions in Greece and the Former Yugoslav Republic of Macedonia A few articles have also been contributed by invited experts who are all noted researchers in the field Altogether the contents of the volume deal with a vast array of problems in Seismic Assessment and Rehabilitation and cover a wide range of possible solutions techniques and proposals It is intended to touch upon many of these aspects separately below Earthquakes constitute possibly the most widely spread and also the most feared of natural hazards Recent earthquakes within the first six months of 2003 such as the Bingöl Earthquake in Turkey and the Algerian earthquake have caused both loss of life and severe damage to property 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

**Seismic Evaluation and Rehabilitation of Structures** Alper Ilki, Michael N. Fardis, 2013-08-15 In the past facilities considered to be at the end of their useful life were demolished and replaced with new ones that better met the functional requirements of modern society including new safety standards Humankind has recently recognised the threats to the environment and to our limited natural resources due to our relentless determination to destroy the old and build anew With the awareness of these constraints and the emphasis on sustainability in future the majority of old structures will be retrofitted to extend their service life as long as feasible In keeping with this new approach the EU's Construction Products Regulation 305/2011 which is the basis of the Eurocodes included the sustainable use of resources as an Essential Requirement for construction So the forthcoming second generation of EN Eurocodes will cover not only the design of new structures but the rehabilitation of existing ones as well Most of the existing building stock and civil infrastructures are seismically deficient When the time comes for a decision to prolong their service life with the help of structural and architectural upgrading seismic retrofitting may be needed Further it is often decided to enhance the earthquake resistance of facilities that still meet their functional requirements and fulfil their purpose if they are not earthquake safe In order to decide how badly a structure needs seismic upgrading or to prioritise it in a population of structures a seismic evaluation is needed which also serves as a guide for the extent and type of strengthening Seismic codes do not sufficiently cover the delicate phase of seismic evaluation nor the many potential technical options for seismic upgrading therefore research is on going and the state of the art is constantly evolving All the more so as seismic evaluation and rehabilitation demand considerable expertise to make best use of the available safety margins in the existing structure to adapt the engineering capabilities and techniques at hand to the particularities of a project to minimise disruption of use etc Further as old structures are very diverse in terms of their materials and layout

seismic retrofitting does not lend itself to straightforward codified procedures or cook book approaches As such seismic evaluation and rehabilitation need the best that the current state of the art can offer on all aspects of earthquake engineering This volume serves this need as it gathers the most recent research of top seismic experts from around the world on seismic evaluation retrofitting and closely related subjects

**Strengthening and Retrofitting of Existing Structures** Aníbal

Costa, António Arêde, Humberto Varum, 2017-10-13 This book presents the fundamentals of strengthening and retrofitting approaches solutions and technologies for existing structures It addresses in detail specific techniques for the strengthening of traditional constructions reinforced concrete buildings bridges and their foundations Finally it discusses issues related to standards and economic decision support tools for retrofitting

Handbook of Research on Seismic Assessment and Rehabilitation of Historic Structures Asteris, Panagiotis G., Plevris, Vagelis, 2015-07-13 Rehabilitation of heritage monuments provides sustainable development and cultural significance to a region The most sensitive aspect of the refurbishment of existing buildings lies in the renovation and recovery of structural integrity and public safety The Handbook of Research on Seismic Assessment and Rehabilitation of Historic Structures evaluates developing contributions in the field of earthquake engineering with regards to the analysis and treatment of structural damage inflicted by seismic activity This book is a vital reference source for professionals researchers students and engineers active in the field of earthquake engineering who are interested in the emergent developments and research available in the preservation and rehabilitation of heritage buildings following seismic activity

**Seismic Rehabilitation Methods for Existing Buildings** Reza Mokarram

Aydenlou, 2020-08-01 Seismic Rehabilitation Methods for Existing Buildings covers various structures effective parameters in seismic improvement and other factors in seismic loading in eight applied chapters with descriptive classification The book offers guidance for a seismic rehabilitation project based on the interpretation of publications FEMA and Iranian seismic rehabilitation regulations no 360 It includes real examples of completed and approved projects to stabilize the seismic improvement issues of existing buildings Six perfectly executed examples with complete refinement details such as modeling step by step improvement studies and executive plans and seismic enhancement images are included The book also explains the classification of non structural element and how to carry out its seismic reconstruction studies and in one of the chapters construction and soil improvement methods are discussed along with a practical example The concepts of seismic rehabilitation in this book are presented with an Info graphic structure that better fixes the concepts in the minds of readers so that when they face a new project they have a more practical use of the content Provides a fully functional way to evaluate model and present details of a seismic rehabilitation plan for a building Presents real seismic refurbishment models and step by step methods for providing examples including images tables and charts

**Buildings and Structures under Extreme Loads** Chiara Bedon, Flavio Stochino, Daniel Honfi, 2020-11-25 Exceptional loads on buildings and structures may have

different causes including high strain dynamic effects due to natural hazards man made attacks and accidents as well as

extreme operational conditions severe temperature variations humidity etc All of these aspects can be critical for specific structural typologies and or materials that are particularly sensitive to external conditions In this regard dedicated and refined methods are required for their design analysis and maintenance under the expected lifetime There are major challenges related to the structural typology and material properties with respect to the key features of the imposed design load Further issues can be derived from the need for risk mitigation or retrofit of existing structures as well as from the optimal and safe design of innovative materials systems Finally in some cases no appropriate design recommendations are available and thus experimental investigations can have a key role within the overall process In this Special Issue original research studies review papers and experimental and or numerical investigations are presented for the structural performance assessment of buildings and structures under various extreme conditions that are of interest for design

**Seismic Rehabilitation of Buildings** Ugo Morelli, 1999-11 Provides the Federal Emergency Management Agency's Mitigation Directorate with 25 recommended tasks that should be undertaken through the agency's Existing Buildings Program EBP in the coming years The EBP's expanded but continuing mission in seismic rehabilitation is to limit fatalities life threatening injuries property economic losses from earthquakes by increasing the number of seismically resistant buildings in all areas of identified earthquake risk Identifies 4 objectives 25 tasks to help make our building stock less vulnerable to earthquake damage Seeks to provide the continuity necessary for an effective Existing Buildings Program

*Advances in Earthquake Engineering for Urban Risk Reduction* S. Tanvir Wasti, Guney Ozcebe, 2006-06-15 Earthquakes affecting urban areas can lead to catastrophic situations and hazard mitigation requires preparatory measures at all levels Structural assessment is the diagnosis of the seismic health of buildings Assessment is the prelude to decisions about rehabilitation or even demolition The scale of the problem in dense urban settings brings about a need for macro seismic appraisal procedures because large numbers of existing buildings do not conform to the increased requirements of new earthquake codes and specifications or have other deficiencies It is the vulnerable buildings liable to cause damage and loss of life that need immediate attention and urgent appraisal in order to decide if structural rehabilitation and upgrading are feasible Current economic efficient and occupant friendly rehabilitation techniques vary widely and include the application either of precast concrete panels or layers strips and patches of fiber reinforced polymers FRP in strategic locations The papers in this book many by renowned authorities in earthquake engineering chart new and vital directions of research and application in the assessment and rehabilitation of buildings in seismic regions While several papers discuss the probabilistic prediction and quantification of structural damage others present approaches related with the in situ and occupant friendly upgrading of buildings and propose both economical and practical techniques to address the problem

**Building for the Future: Durable, Sustainable, Resilient** Alper Ilki, Derya Çavunt, Yavuz Selim Çavunt, 2023-05-31 This book presents the proceedings of the fib Symposium Building for the future Durable Sustainable Resilient held in Istanbul Turkey on 5-7 June

2023 The book covers topics such as concrete and innovative materials structural performance and design construction methods and management and outstanding structures fib The International Federation for Structural Concrete is a not for profit association whose mission is to develop at an international level the study of scientific and practical matters capable of advancing the technical economic aesthetic and environmental performance of concrete construction Theory and Practice in Earthquake Engineering and Technology T. G. Sitharam, Sreevalsa Kolathayar, Ravi S. Jakka, Vasant Matsagar, 2022-06-07 This book contains diverse topics relevant to earthquake engineering and technology The chapters are of interest to readers from various disciplines as the different chapters discuss popular topics on earthquake engineering and allied disciplines The chapters have adequate illustrations and tables for clarifying underlying concepts The reader can understand the fundamental concepts easily and the book is highly useful for practice in the field in addition to classroom learning *Drift-Driven Design of Buildings* Santiago Pujol, Ayhan Irfanoglu, Aishwarya Puranam, 2022-05-12 This book summarizes the most essential concepts that every engineer designing a new building or evaluating an existing structure should consider in order to control the damage caused by drift deformation induced by earthquakes It presents the work on earthquake engineering done by Dr Mete Sozen and dozens of his collaborators and students over decades of experimentation analysis and reconnaissance Many of the concepts produced through this work are integral part of earthquake engineering today Nevertheless the connection between the concepts in use today and the original sources is not always explained *Drift Driven Design of Buildings* summarizes Sozen s research provides common language and notation from subject to subject provides examples and supporting data and adds historical context as well as class notes that were the result of Sozen s dedication to teaching It distills reinforced concrete building design to resist earthquake demands to its essence in a way that no other available book does The recommendations provided are not only essential but also of the utmost simplicity which is not the result of uninformed neglect of relevant parameters but rather the result of careful consideration and selection of parameters to retain only those that are most critical Features Provides the reader with a clear understanding of the essential features that control the seismic response of RC buildings Describes a simple perhaps the simplest seismic design method available Includes the underlying hard data to support and explain the methods described Presents decades of work by one of the most prolific and brilliant civil engineers in the United States in the second half of the 20th century *Drift Driven Design of Buildings* serves as a useful guide for civil and structural engineering students for self study or in class learning as well as instructors and practicing engineers **Earthquake Resistant Engineering Structures IX** C. A. Brebbia, Santiago Hernández, 2013-07-08 In earthquake prone regions of the world it is important not only to ensure that new facilities meet optimal standards but also that existing structures and infrastructure be retrofitted and rehabilitated As world populations concentrate in urban areas the stakes in human life and property of such natural disasters as earthquakes becomes higher and higher This has been driving research on advances in the field These advances

are presented biennially at a conference organised by the Wessex Institute of Technology The advances presented at the ninth conference in the series which began in 1991 are presented in this book The papers cover Plates and other geological risks Earthquake prediction Microzoning Remote sensing Monitoring Early warning systems Seismic codes Seismic hazard and vulnerability Tsunamis Seismic isolation and energy dissipation Structural dynamics Building performance during earthquakes Retrofitting Lifelines Material mechanics and characterisation Nonlinear numerical analysis Performance based design Experimental studies Forensic analysis Safety and security Socio economic issues Insurance related issues Innovative technologies Case studies      Perspectives on European Earthquake Engineering and Seismology Atilla Ansal, 2014-09-01

This book collects 5 keynote and 15 topic lectures presented at the 2nd European Conference on Earthquake Engineering and Seismology 2ECEES held in Istanbul Turkey from August 24 to 29 2014 The conference was organized by the Turkish Earthquake Foundation Earthquake Engineering Committee and Prime Ministry Disaster and Emergency Management Presidency under the auspices of the European Association for Earthquake Engineering EAE and European Seismological Commission ESC The book s twenty state of the art papers were written by the most prominent researchers in Europe and address a comprehensive collection of topics on earthquake engineering as well as interdisciplinary subjects such as engineering seismology and seismic risk assessment and management Further topics include engineering seismology geotechnical earthquake engineering seismic performance of buildings earthquake resistant engineering structures new techniques and technologies and managing risk in seismic regions The book also presents the Third Ambraseys Distinguished Award Lecture given by Prof Robin Spence in honor of Prof Nicholas N Ambraseys The aim of this work is to present the state of the art and latest practices in the fields of earthquake engineering and seismology with Europe s most respected researchers addressing recent and ongoing developments while also proposing innovative avenues for future research and development Given its cutting edge content and broad spectrum of topics the book offers a unique reference guide for researchers in these fields Audience This book is 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      NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings (FEMA 172)

Federal Emergency Management Agency, 2013-04-14 This publication on seismic strengthening of existing buildings is one of a series that FEMA is sponsoring to encourage local decision makers design professionals and other interested groups to undertake a program of mitigating the risks posed by existing hazardous buildings in the event of an earthquake Publications in this series are being prepared under the National Earthquake Hazards Reduction Program NEHRP and examine both the engineering architectural aspects and societal impacts of seismic rehabilitation FEMA s existing buildings activities are structured to result in a coherent cohesive carefully selected and planned reinforcing set of documents designed for national



applicability The resulting publications descriptive reports handbooks and supporting documentation provide guidance primarily to local elected and appointed officials and design professionals on how to deal not only with earthquake engineering problems but also with the public policy issues and societal dislocations associated with major seismic events This handbook of techniques for solving a variety of seismic rehabilitation problems and its companion publication on the seismic evaluation of existing buildings reflect basic input provided by two organizations recognized for their retrofit evaluation and design experience as well as the results of a consensus development activity carried out by the Building Seismic Safety Council BSSC The preliminary version of this document the NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings was developed for FEMA by URS John A Blume and Associates Engineers URS Blume A companion volume the NEHRP Handbook for the Seismic Evaluation of Existing Buildings for which a preliminary version was developed for FEMA by the Applied Technology Council ATC provides a method for evaluating existing buildings to identify those that are likely to be seismically hazardous The BSSC project initiated at the request of FEMA in October 1988 has focused on identification and resolution of technical issues in and appropriate revision of the two handbooks by a 22 member Retrofit of Existing Buildings REB Committee composed of individuals possessing expertise in the various subjects needed to address seismic rehabilitation

**Proceedings of the 7th International Conference on Concrete Repair, Rehabilitation and Retrofitting** Hans Beushausen,Joanitta Ndawula,Mark Alexander,Frank Dehn,Pilate Moyo,2024-10-31

This book gathers contributions presented at the 7th International Conference on Concrete Repair Rehabilitation and Retrofitting ICCRRR held in Cape Town South Africa on November 4 6 2024 The conference aims at sharing knowledge and experience on current developments in concrete technology durability design and service life management condition assessment of concrete structures and concrete repair rehabilitation and retrofitting The contributions which were selected through a rigorous international peer review process share exciting ideas that will spur novel research directions and foster new multidisciplinary collaborations

Why Do Buildings Collapse in Earthquakes? Building for Safety in Seismic Areas Robin Spence,Emily So,2021-08-09 WHY DO BUILDINGS COLLAPSE IN EARTHQUAKES Learn from the personal experience and insights of leading earthquake engineering specialists as they examine the lessons from disasters of the last 30 years and propose a path to earthquake safety worldwide Why Do Buildings Collapse in Earthquakes Building for Safety in Seismic Areas delivers an insightful and comprehensive analysis of the key lessons taught by building failures during earthquakes around the world The book uses empirical evidence to describe the successes of earthquake engineering and disaster preparedness as well as the failures that may have had tragic consequences Readers will learn what makes buildings in earthquake zones vulnerable what can be done to design build and maintain those buildings to reduce or eliminate that vulnerability and what can be done to protect building occupants Those who are responsible for the lives and safety of building occupants and visitors architects designers engineers and building owners or managers will learn how to provide

adequate safety in earthquake zones The text offers useful and accessible answers to anyone interested in natural disasters generally and those who have specific concerns about the impact of earthquakes on the built environment Readers will benefit from the inclusion of A thorough introduction to how buildings have behaved in earthquakes including a description of the world's most lethal earthquakes and the fatality trend over time An exploration of how buildings are constructed around the world including considerations of the impact of climate and seismicity on home design A discussion of what happens during an earthquake including the types and levels of ground motion landslides tsunamis and sequential effects and how different types of buildings tend to behave in response to those phenomena What different stakeholders can do to improve the earthquake safety of their buildings The owners and managers of buildings in earthquake zones and those responsible for the safety of people who occupy or visit them will find Why Do Buildings Collapse in Earthquakes Building for Safety in Seismic Areas essential reading as will all architects designers and engineers who design or refurbish buildings in earthquake zones

*Insights and Innovations in Structural Engineering, Mechanics and Computation* Alphose Zingoni, 2016-11-25 Insights and Innovations in Structural Engineering Mechanics and Computation comprises 360 papers that were presented at the Sixth International Conference on Structural Engineering Mechanics and Computation SEMC 2016 Cape Town South Africa 5-7 September 2016 The papers reflect the broad scope of the SEMC conferences and cover a wide range of engineering structures buildings bridges towers roofs foundations offshore structures tunnels dams vessels vehicles and machinery and engineering materials steel aluminium concrete masonry timber glass polymers composites laminates smart materials

*Proceedings of the Eleventh European Conference on Earthquake Engineering* Alain Pecker, Philippe Bisch, Pierre Labbé, 1998

**Earthquake Risk Reduction** David J. Dowrick, 2003-09-12 Encompassing theory and field experience this book covers all the main subject areas in earthquake risk reduction ranging from geology seismology structural and soil dynamics to hazard and risk assessment risk management and planning engineering and the architectural design of new structures and equipment Earthquake Risk Reduction outlines individual national weaknesses that contribute to earthquake risk to people and property calculates the seismic response of soils and structures using the structural continuum Subsoil Substructure Superstructure Non structure evaluates the effectiveness of given designs and construction procedures for reducing casualties and financial losses provides guidance on the key issue of choice of structural form presents earthquake resistant designs methods for the four main structural materials steel concrete reinforced masonry and timber as well as for services equipment plant and non structural architectural components contains a chapter devoted to problems involved in improving retrofitting the existing built environment Compiled from the author's extensive professional experience in earthquake engineering this key text provides an excellent treatment of the complex multidisciplinary process of earthquake risk reduction This book will prove an invaluable reference and guiding tool to practicing civil and structural engineers and architects researchers and postgraduate students in seismology local

governments and risk management officials

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