Retrofitting Of Concrete Columns By Conventional Steel Method Structural Rehabilitation Using Retrof

Reinforced concrete columns play a very important role in structural performance. As such, it is essential to apply a suitable analytical tool to estimate their structural behaviour considering all failure mechanisms such as axial, shear, and flexural failures. This book highlights the development of a fiber beam-column element accounting for shear effects and the effect of tension stiffening through reinforcement-to-concrete bond, along with the employment of suitable constitutive material laws.

This book gives an insight to check the capacity of retrofitted columns, which will help the designer to restrengthen the damaged structures of earth quake area professionally. The study title 'Restrengthening of Concrete Columns' covers intermediate columns of different concrete strength, with fixed reinforcement ratio and cross-sectional dimensions. Concrete strength varies from 2000 psi to 4000 psi with an interval of 1000 psi. Traditional method of restrengthening is employed by drilling holes and an additional cover is provided along with a cage of reinforcement. The results obtained illustrate remarkable increase (up to 50 %) in the load carrying capacity of retrofitted intermediate columns. This book is a useful tool for Civil engineers having interest in structures rehabilitation.

Retrofitting of building structures, including maintenance, rehabilitation, and strengthening, is not only an important issue in urban construction and management, but also a frequent problem to structural engineers in property management disciplines. Based on the contributors’ hands-on experience, Retrofitting Design of Building Structures covers structural retrofitting practices, the basic principles of structural analysis and design, and various innovatively-used structural codes for the design, assessment, and retrofitting of building structures using newly-developed technologies worldwide. Beginning with the procedure of structural retrofitting, this book gradually introduces the significance of structural retrofitting; the inspection methods for structural materials, structural deformation, and damages; retrofitting design methods and construction requirements of various structural systems; and practical examples of structural retrofitting design and construction. In the introduction of various examples, it emphasizes not only conceptual design, but also constructional procedure design, so that a structural retrofitting design work should be completed by both structural analysis and detailed constructional measures. The book provides a complete resource for experienced professionals as well as teachers and students.

Fibre-reinforced polymer (FRP) reinforcement has been used in construction as either internal or external reinforcement for concrete structures in the past decade. This book provides the latest research findings related to the development, design and application of FRP reinforcement in new construction and rehabilitation works. The topics include FRP properties and bond behaviour, externally bonded reinforcement for flexure, shear and confinement, FRP structural shapes, durability, member behaviour under sustained loads, fatigue loads and blast loads, prestressed FRP tendons, structural strengthening applications, case studies, and codes and standards.

This paper presents a review of the various seismic retrofitting techniques currently being carried out for bridge structures. After evaluating the performance of existing bridges in past earthquakes and their most common modes of failure, a systematic review of bridge retrofit is discussed. It includes the retrofit of foundations, concrete columns, bent cap beams and beam-column joints, as well as steel bracing. The use of restrainers is discussed as well as the possible improvements to bearing supports. Examples of bridge retrofit practice in California and British Columbia are presented.

The book is an effort to bring forth the process involved in retrofitting deformed or cracked concrete columns with Fiber Reinforced Plastic overlays and to analyse the properties of the columns before and after retrofitting. It details the various process available for retrofitting and details the calculations and analysis of a typical process using multiple samples of the columns. It is statistical in nature outlining the observation from the experimental results and their interpretation.

In the Middle East region and many countries in the world, older reinforced concrete (RC) columns are deemed to be weak in seismic resistance because of their low amount of reinforcement, low grades of concrete, and large spacing between the transverse reinforcement. The capacity of older RC columns that are also slender is further reduced due to the secondary moments. Appropriate retrofit techniques can improve the capacity and behavior of concrete members. In this study, externally bonded Carbon Fiber Reinforced Polymer (CFRP) retrofit technique was implemented to improve the behavior of RC columns tested under constant axial load and cyclic lateral load. The study included physical testing of five half-scale slender RC columns, with shear span to depth ratio of 7. Three specimens represented columns in a 2-story, and two specimens represented columns in a 4-story building. All specimens had identical cross sections, reinforcement detail, and concrete strength. Two specimens were control, two specimens were retrofit with CFRP in the lateral direction, and one specimen retrofit in the longitudinal and lateral directions. A computer model was created to predict the lateral load-displacement relations. The experimental results show improvement in the retrofit specimens in strength, ductility, and energy dissipation. The effect of retrofitting technique applied to two full-scale prototype RC buildings, a 2-story and a 4-story building located in two cities in Iraq, Baghdad, and Erbil, was determined using SAP2000.

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).

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

There is a growing interest on infrastructure retrofitting due to updated seismic codes and increased service loads. There may be some economical reasons or preservation needs to strengthen a structure instead of demolishing it. For strengthening purposes alternatives include steel jacketing and Fiber Reinforced Plastic (FRP) wrapping. This study focuses on Slurry Infiltrated Mat Concrete (SIMCON) as an option for strengthening of reinforced concrete columns. Before SIMCON is applied routinely for strengthening of a column, however, certain critical construction and constructibility factors affecting the jacketed column behavior must be resolved. In this study, the frost durability of SIMCON was examined, factors associated with the construction of a SIMCON jacket were identified, the influence of these factors on service load and ultimate state behavior were evaluated, the criticality of these factors was determined, and general guidelines for the construction or design of SIMCON jackets on existing columns were developed. In addition, an approximate cost of SIMCON jackets for existing reinforced concrete columns was developed in order to evaluate the economic viability of the SIMCON jacket. SIMCON exhibited satisfactory deicer salt scaling resistance, even without the presence of entrained air. No significant effect of cracking on scaling was observed. Several construction aspects of jacketing were studied analytically. Bonding was not found to be necessary for SIMCON jacketing of a column. The most important factor is the end connections of a SIMCON jacket for load and moment transfer. Other critical factors were thickness and strength tolerances of SIMCON jacket. The construction costs of SIMCON jacket were estimated based on available data. This and some other strengthening technique cost data showed that SIMCON jacketing is an economically viable technique.

The book describes a detailed comparision of the various engineering properties of an FRP column and a reinforced concrete column. Also, a detailed understanding of the various processes involved in the manufacturing and testing of a FRP composite for retrofitting has been presented. There is a considerable number of existing reinforced concrete structures that do not meet current design standards because of inadequate design and/or construction or need structural upgrading to meet new seismic design requirements. Inadequate performance of this type of structures is a major concern from public safety standpoint. This paper presents an experimental research program aimed at developing a retrofitting technique that utilizes locally available high strength, lightweight, corrosion resistance advanced composites for retrofitting existing reinforced concrete columns. The proposed technique consists of applying Glass Fiber Reinforced Plastic (GFRP) to all surfaces of the concrete column to increase its stiffness and flexural strength.

Abstract: Traditional rebar reinforcement methods in concrete columns have been accepted for many years as the common practice among designers and contractors. There has been a tremendous amount of research completed and designers are

capable of predicting the future performance of the columns. More recently, retrofit methods have been used on aging concrete columns. This includes adding an additional layer of concrete or composite material around the existing column to slow the deterioration and to increase the concrete confinement. Current models exist in the use of a combination of a rebar cage and concrete as the retrofit method. Fiber-reinforced polymer (FRP) wraps are fast becoming a new form of technology to replace traditional rebar retrofit technology. The fiber-reinforced polymer wraps are a composite material that can be attached to the existing concrete column using an epoxy resin. The wrap increases the concrete confinement of the column and provides support for the concrete dilation in the column. However, FRP wraps are not heavily used in structural applications because there is not an accepted model that has been proven to accurately predict future strength characteristics of the confined concrete column. The focus of this research project is to use the results of an already completed test of concrete columns confined by FRP wraps, and compare the resulting stress-strain curves to the commonly proposed modeling technology available. FRP modeling is still relatively new and there is not a widely accepted model. The purpose of this research project is to determine how accurately the proposed FRP models predict the strength of the tested columns. There are many different models that have been proposed, but the key to the future of FRP retrofitting is to create a widely accepted, reliable model that engineers can use in design. It is important to normalize the design process of FRP retrofitted columns in order to better use the technology in the future.

This book comprises select papers presented at the International Conference on Trends and Recent Advances in Civil Engineering (TRACE 2018). The book covers a wide range of topics related to recent advancements in structural engineering, structural health monitoring, rehabilitation and retrofitting of structures, and earthquake-resistant structures. Based on case studies and laboratory investigations, the book highlights latest techniques and innovative methods for building repair and maintenance. Recent development in materials being used in structural rehabilitation and retrofitting is also discussed. The contents of this book can be useful for researchers and professionals working in structural engineering and allied areas.

Because of their structural simplicity, bridges tend to beparticularly vulnerable to damage and even collapse when subjectedto earthquakes or other forms of seismic activity. Recentearthquakes, such as the ones in Kobe, Japan, and Oakland,California, have led to a heightened awareness of seismic risk andhave revolutionized bridge design and retrofit philosophies. In Seismic Design and Retrofit of Bridges, three of the world's topauthorities on the subject have collaborated to produce the mostexhaustive reference on seismic bridge design currently available.Following a detailed examination of the seismic effects of actualearthquakes on local area bridges, the authors demonstrate designstrategies that will make these and similar structures optimallyresistant to the damaging effects of future seismicdisturbances. Relying heavily on worldwide research associated with recentquakes, Seismic Design and Retrofit of Bridges begins with anin-depth treatment of seismic design philosophy as it applies tobridges. The authors then describe the various geotechnicalconsiderations specific to bridge design, such as soil-structureinteraction and traveling wave effects. Subsequent chapters coverconceptual and actual design of various bridge superstructures, andmodeling and analysis of these structures. As the basis for their design strategies, the authors' focus is onthe

widely accepted capacity design approach, in which particularlyvulnerable locations of potentially inelastic flexural deformationare identified and strengthened to accommodate a greater degree ofstress. The text illustrates how accurate application of thecapacity design philosophy to the design of new bridges results instructures that can be expected to survive most earthquakes withonly minor, repairable damage. Because the majority of today's bridges were built before thecapacity design approach was understood, the authors also devoteseveral chapters to the seismic assessment of existing bridges,with the aim of designing and implementing retrofit measures toprotect them against the damaging effects of future earthquakes.These retrofitting techniques, though not considered appropriate inthe design of new bridges, are given considerable emphasis, sincethey currently offer the best solution for the preservation ofthese vital and often historically valued thoroughfares. Practical and applications-oriented, Seismic Design and Retrofit ofBridges is enhanced with over 300 photos and line drawings toillustrate key concepts and detailed design procedures. As the onlytext currently available on the vital topic of seismic bridgedesign, it provides an indispensable reference for civil,structural, and geotechnical engineers, as well as students inrelated engineering courses. A state-of-the-art text on earthquake-proof design and retrofit ofbridges Seismic Design and Retrofit of Bridges fills the urgent need for acomprehensive and up-to-date text on seismic-ally resistant bridgedesign. The authors, all recognized leaders in the field,systematically cover all aspects of bridge design related toseismic resistance for both new and existing bridges. * A complete overview of current design philosophy for bridges,with related seismic and geotechnical considerations * Coverage of conceptual design constraints and their relationshipto current design alternatives * Modeling and analysis of bridge structures * An exhaustive look at common building materials and theirresponse to seismic activity * A hands-on approach to the capacity design process * Use of isolation and dissipation devices in bridge design * Important coverage of seismic assessment and retrofit design ofexisting bridges Performance of bridges during previous earthquakes has demonstrated that many structural failures could be attributed to seismic deficiencies in bridge columns. Lack of transverse reinforcement and inadequate splicing of longitudinal reinforcement in potential plastic hinge regions of columns constitute primary reasons for their poor performance. A number of column retrofit techniques have been developed and tested in the past. These techniques include steel jacketing, reinforced concrete jacketing and use of transverse prestressing (RetroBelt) for concrete confinement, shear strengthening and splice clamping. A new retrofit technique, involving fibre reinforced polymer (FRP) jacketing has emerged as a convenient and structurally sound alternative with improved durability. The new technique, although received acceptance in the construction industry, needs to be fully developed as a viable seismic retrofit methodology, supported by reliable design and construction procedures. The successful application of externally applied FRP jackets to existing columns, coupled with deteriorating bridge infrastructure, raised the possibility of using FRP reinforcement for new construction. Stay-in-place formwork, in the form of FRP tubes are being researched for its feasibility. The FRP stay-in-place tubes offer ease in construction, convenient formwork, and when left in place, the protection of concrete against environmental effects, including the protection of steel reinforcement against corrosion, while also serving as column transverse reinforcement. Combined experimental and analytical research was conducted in the current project to i) improve the performance

of FRP column jacketing for existing bridge columns, and ii) to develop FRP stay-in-place formwork for new bridge columns. The experimental phase consisted of design, construction and testing of 7 full-scale reinforced concrete bridge columns under simulated seismic loading. The columns represented both existing seismically deficient bridge columns, and new columns in stay-in-place formwork. The existing columns were deficient in either shear, or flexure, where the flexural deficiencies stemmed from lack of concrete confinement and/or use of inadequately spliced longitudinal reinforcement. The test parameters included cross-sectional shape (circular or square), reinforcement splicing, column shear span for flexure and shear-dominant behaviour, FRP jacket thickness, as well as use of FRP tubes as stay-in-place formwork, with or without internally embedded FRP crossties. The columns were subjected to a constant axial compression and incrementally increasing inelastic deformation reversals. The results, presented and discussed in this thesis, indicate that the FRP retrofit methodology provides significant confinement to circular and square columns, improving column ductility substantially. The FRP jack also improved diagonal tension capacity of columns, changing brittle shear-dominant column behavior to ductile flexure dominant response. The jackets, when the transverse strains are controlled, are able to improve performance of inadequately spliced circular columns, while remain somewhat ineffective in improving the performance of spliced square columns. FRP stay-in-place formwork provides excellent ductility to circular and square columns in new concrete columns, offering tremendous potential for use in practice. The analytical phase of the project demonstrates that the current analytical techniques for column analysis can be used for columns with external FRP reinforcement, provided that appropriate material models are used for confined concrete, FRP composites and reinforcement steel. Plastic analysis for flexure, starting with sectional moment-curvature analysis and continuing into member analysis incorporating the formation of plastic hinging, provide excellent predictions of inelastic force-deformation envelopes of recorded hysteretic behaviour. A displacement based design procedure adapted to FRP jacketed columns, as well as columns in FRP stay-in-place formwork provide a reliable design procedure for both retrofitting existing columns and designing new FRP reinforced concrete columns.

"This study is aimed to develop a new seismic retrofit technique of reinforced concrete (RC) beams, columns, and their joints with lightweight steel sheets and steel plates, to validate the retrofit technique with testing of two 4/5-scaled beam-column assemblage specimens, and to develop a strut-and-tie model to ascertain the force transfer mechanism of beam-column joints under seismic loads. Because of the introduction of thin steel sheets, weld joints that were used in the conventional steel jacket of RC columns could be costly in field applications. Nailed joints of two types, interlocked and lap-spliced, were therefore proposed in this study"--Abstract, leaf iii.

Understanding and recognising failure mechanisms in concrete is a fundamental pre-requisite to determining the type of repair, or whether a repair is feasible. This title provides a review of concrete deterioration and damage, as well as looking at the problem of defects in concrete. It also discusses condition assessment and repair techniques. Part one discusses failure mechanisms in concrete and covers topics such as causes and mechanisms of deterioration in reinforced concrete, types of damage in concrete

structures, types and causes of cracking and condition assessment of concrete structures. Part two reviews the repair of concrete structures with coverage of themes such as standards and guidelines for repairing concrete structures, methods of crack repair, repair materials, bonded concrete overlays, repairing and retrofitting concrete structures with fiber-reinforced polymers, patching deteriorated concrete structures and durability of repaired concrete. With its distinguished editor and international team of contributors, Failure and repair of concrete structures is a standard reference for civil engineers, architects and anyone working in the construction sector, as well as those concerned with ensuring the safety of concrete structures. Provides a review of concrete deterioration and damage Discusses condition assessment and repair techniques, standards and guidelines

This book provides a collection of recent research works, related to structural stability and durability, service life, reinforced concrete structures, recycled materials, and sustainability with endogenic materials. Intended as an overview of the current state of knowledge, the book will benefit scientists, students, practitioners, lecturers and other interested parties. At the same time, the topics covered are relevant to a variety of scientific and engineering disciplines, including civil, materials and mechanical engineering.

Abstract: As our infrastructure continues to age, retrofitting of existing structural members is becoming a very common practice. Several methods have been researched and proven effective in increasing the axial load capacity of reinforced concrete columns. These methods include concrete, steel, and fiber reinforced polymer (FRP) jackets. Reinforcement for concrete jacketed specimens has traditionally been provided by rebar reinforcement as well as welded wire fabric (WWF). FRP has been applied as a wrap and in composite plate form. A new reinforcement product, Prefabricated Cage System (PCS), is suggested as a possible alternative retrofit reinforcement for concrete jackets. A thorough literature review of concrete retrofit and confinement research was conducted. The aforementioned retrofits are experimentally tested and compared with the new PCS reinforcement product as part of this research. Seventeen circular columns were constructed, retrofitted, and tested under axial compression until failure. Axial load-displacement responses of the specimens were recorded and the critical behaviors of the specimens were documented during testing. Data from the testing is analyzed and compared. Additionally, innovative concepts to accurately determine the behavior of concrete jacket retrofitted columns are presented, which may assist in future concrete jacket retrofit modeling.

To ensure better performance for a range of existing reinforced concrete structures in seismic regions with substandard structural details, seismic retrofit is an economical solution. Hence, this chapter presents some of the available results in which fiber-reinforced polymer (FRP) composites can be used for damage-controllable structures. For example, the performance of existing reinforced concrete structures whose components are vulnerable to shear failure, flexural-compression failure, joint reinforcement bond failure, or longitudinal reinforcement lap splice failure and retrofitted with FRPs is described. Novel concepts of modern constructions with controllability and recoverability using FRP composites

are addressed.

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.

Many more people are coming to live in earthquake-prone areas, especially urban ones. Many such areas contain low-rise, low-cost housing, while little money is available to retrofit the buildings to avoid total collapse and thus potentially save lives. The lack of money, especially in developing countries, is exacerbated by difficulties with administration, implementation and public awareness. The future of modern earthquake engineering will come to be dominated by new kinds of measuring technologies, new materials developed especially for low-rise, low-cost buildings, simpler and thus lower cost options for retrofitting, cost cutting and raising public awareness. The book covers all the areas involved in this complex issue, from the prevention of total building collapse, through improvement techniques, to legal, financial, taxation and social issues. The contributors have all made valuable contributions in their own particular fields; all of them are or have been closely involved with the issues that can arise in seismic zones in any country. The recent research results published here offer invaluable pointers to practicing engineers and administrators, as well as other scientists whose work involves saving the lives and property of the many millions of people who live and work in hazardous buildings.

The official proceedings of the 10th world conference on earthquake engineering in Madrid. Coverage includes damage in recent earthquakes, seismic risk and hazard, site effects, structural analysis and design, seismic codes and standards, urban planning, and expert system application.

The First International Conference on Concrete Repair, Rehabilitation and Retrofitting (ICCRRR 2005) was held in Cape Town, South Africa, from 21-23 November 2005. The conference was a collaborative venture by researchers from the South African Research Programme in Concrete Materials (based at the Universities of Cape Town and The Witwatersrand) and The Construction Materials Section at Leipzig University in Germany. The conference has come at an opportune moment for concrete construction worldwide and sought to focus on an increasingly important aspect in modern infrastructure provision and retention: that of appropriately repairing, maintaining, rehabilitating, and if necessary retrofitting existing infrastructure with a view to extending its life and maximising its economic return. The conference Proceedings contain papers, presented at the conference, and classified into a total of 15 sub themes which can be grouped under the four main themes of (i) Concrete durability aspects, (ii) Condition assessment of concrete structures,

(iii) Concrete repair, rehabilitation and retrofitting, and (iv) Performance monitoring and health assessment. The major interest in terms of submissions exists in the fields of concrete durability aspects in connection with material compositions, NDE/NDT and measurement techniques, repair methods and materials, and structural strengthening and retrofitting techniques. The large number of high-quality papers presented and the wide range of relevant topics covered confirm that these Proceedings will be a valued reference for many working in the important fields of concrete durability and repair and that they form a suitable base for discussion and provide suggestions for future development and research.

This book presents the development of a new method to predict load-deformation responses of reinforced concrete (RC) columns both with and without fiber reinforced polymer (FRP) jacketing under seismic loading. In the case of the flexure mechanism, the section analysis was applied considering the confinement effect of FRP jacketing. This section analysis was combined with the shear mechanism, which was modeled based on the truss mechanism. The flexure-shear models showed significant interactions due to the reduction of reinforcement secant stiffness after yielding and concrete deterioration. The analytical method was verified using an experimental program consisting of square columns strengthened with FRP-jacketing that was tested under reversed cyclic loading, and various parameters including steel reinforcement and fiber ratio were investigated. The proposed analytical method is more effective for predicting the load-deformation relationship, including the post-peak behavior of FRP-jacketed RC columns, than the conventional analytical method and proves that fibers with high fracture strain can provide good ultimate ductility.

Evaluates the effects of different retrofit applications on the global response of short-spanned reinforced concrete bridges. Retrofitting methods addressed include steel jacketing of columns, foundation, and abutment retrofit.

In a presentation that formalizes what makes up decision based design, Decision Based Design defines the major concepts that go into product realization. It presents all major concepts in design decision making in an integrated way and covers the fundamentals of decision analysis in engineering design. It also trains engineers to understand the impacts of design decision. The author teaches concepts in demand modeling and customer preference modeling and provides examples. This book teaches most fundamental concepts encountered in engineering design like: concept generation, multiattribute decision analysis, reliability engineering, design optimization, simulation, and demand modeling. The book provides the tools engineering practitioners and researchers need to first understand that engineering design is best viewed as a sequence of decisions made by the stakeholders involved and then apply the decision based design concepts in practice. It teaches fundamental concepts encountered in engineering design, such as concept generation, multiattribute decision analysis, reliability engineering, design optimization, simulation, and demand

modeling. This book helps students and practitioners understand that there is a rigorous way to analyze engineering decisions taking into consideration all the potential technical and business impacts of their decisions. It can be used in its entirety to teach a course in decision based design, while selected chapters can also be used to cover courses in subdisciplines that make up decision based design.

Fibre-reinforced polymer (FRP) reinforcement has been used in construction as either internal or external reinforcement for concrete structures in the past decade. This book provides the latest research findings related to the development, design and application of FRP reinforcement in new construction and rehabilitation works. The topics include FRP properties and bond behaviour, externally bonded reinforcement for flexure, shear and confinement, FRP structural shapes, durability, member behaviour under sustained loads, fatigue loads and blast loads, prestressed FRP tendons, structural strengthening applications, case studies, and codes and standards. Contents: .: Volume 1: Keynote Papers; FRP Materials and Properties; Bond Behaviour; Externally Bonded Reinforcement for Flexure; Externally Bonded Reinforcement for Shear; Externally Bonded Reinforcement for Confinement; FRP Structural Shapes; Volume 2: Durability and Maintenance; Sustained and Fatigue Loads; Prestressed FRP Reinforcement and Tendons; Structural Strengthening; Applications in Masonry and Steel Structures; Field Applications and Case Studies; Codes and Standards. Readership: Upper level graduates, graduate students, academics and researchers in materials science and engineering; practising engineers and project managers