Effects Of Earthquake Ground Motion Selection And Scaling

A rotational ground motion is seismic wave that causes tipping or twisting at the base of a structure. These motions are non-translational. This differs from non-rotational motions which translate the base of a structure. Recent recordings of rotational earthquake ground motions have shown that rotational ground motions can be much greater than originally thought. While far-field ground motion rotations have agreed well with current theory, recent near-field measurements have shown that the magnitudes of these rotations can be 10 to 100 times greater than originally thought (Liu et al., 2009). This may possibly lead to a large increase in structure displacements and thus increased stress on these structures.Using a small data set from Taiwan, a rigid stick was subjected to the recorded rotational and translational ground motions. Comparing the displacements between translational only ground motions to combined translational and rotational motions, it was found that a 15 to 60 percent increase in displacements

occurred with the addition of rotational ground motions. However, the data used is only from one site and contains only 52 earthquakes, so results are highly skewed to this particular site. To look into how different sites and conditions would affect the results from Taiwan, a closed form solution of a seismic wave field was generated and the effects of changing different parameters was examined. This showed that the amount of displacement is highly dependent on the site conditions and other aspects specific to each earthquake. Finally, a set of synthetic three dimensional waves, generated from the seismology program "tk" for a site subjected to the Northridge Earthquake, were put into DEEPSOIL. By adjusting soil the soil dampening, a one dimensional site response was able to produce accelerograms that matched the three dimensional synthetic accelerograms. The matching of these accelerograms shows us that the modelling of a site using a one dimensional method does not mean that the motions are one dimensional. More analysis of empirical data is needed to fully understand these concepts and how much of an effect rotational motions have on displacements. This data is currently being collected by seismologists around the world.

In the course of reassessing seismic hazards at the Idaho National Engineering Laboratory (INEL), several key issues have been raised concerning the effects of the earthquake source and site geology on potential strong ground motions that might be generated by a large earthquake. The design earthquake for the INEL is an approximate moment magnitude (M{sub w}) 7 event that may occur on the southern portion of the Lemhi fault, a Basin and Range normal fault that is located on the northwestern boundary of the eastern Snake River Plain and the INEL, within 10 to 27km of several major facilities. Because the locations of these facilities place them at close distances to a large earthquake and generally along strike of the causative fault, the effects of source rupture dynamics (e.g., directivity) could be critical in enhancing potential ground shaking at the INEL. An additional source issue that has been addressed is the value of stress drop to use in ground motions predictions. In terms of site geology, it has been questioned whether the interbedded volcanic stratigraphy beneath the ESRP and the INEL attenuates ground motions to a greater degree than a typical rock site in the western US. These three issues have been investigated employing a stochastic ground motion methodology which

incorporates the Band-Limited-White-Noise source model for both a point source and finite fault, random vibration theory and an equivalent linear approach to model soil response.

The specialty section Earthquake Engineering is one branch of Frontiers in Built Environment and welcomes critical and in-depth submissions on earthquake ground motions and their effects on buildings and infrastructures. Manuscripts should yield new insights and ultimately contribute to a safer and more reliable design of building structures and infrastructures. The scope includes the characterization of earthquake ground motions (e.g. near-fault, far-fault, short-period, long-period), their underlying properties, their intrinsic relationship with structural responses, and the true behaviors of building structures and infrastructures under risky and uncertain ground motions. More specific topics include recorded ground motions, generated ground motions, response spectra, stochastic modeling of ground motion, critical excitation, geotechnical aspects, soil mechanics, soil liquefaction, soil-structure interactions, pile foundations, earthquake input energy, structural control, passive control, active control, base-isolation, steel structures, reinforced concrete structures, wood structures,

building retrofit, structural optimization, uncertainty analysis, robustness analysis, and redundancy analysis. This eBook includes four original research papers, in addition to the Specialty Grand Challenge article, on the critical earthquake response of elastic-plastic structures under near-fault or long-duration ground motions which were published in the specialty section Earthquake Engineering. In the early stage of dynamic nonlinear response analysis of structures around 1960s, a simple hysteretic structural model and a simple sinusoidal earthquake ground motion input were dealt with together with random inputs. The steady-state response was tackled by an equivalent linearization method developed by Caughey, Iwan and others. In fact, the resonance plays a key role in the earthquake-resistant design and it has a strong effect even in case of near-fault ground motions. In order to draw the steady-state response curve and investigate the resonant property, two kinds of repetition have to be introduced. One is a cycle, for one forced input frequency, of the initial guess of the steady-state response amplitude, the construction of the equivalent linear model, the analysis of the steady-state response amplitude using the equivalent linear model and the update of the equivalent *linear model based on the computed steady-state response amplitude. The other is the sweeping over a range of forced input frequencies. This process is quite tedious. Four original research papers included in this eBook propose a new approach to overcome this difficulty. Kojima and Takewaki demonstrated that the elastic-plastic response as continuation of free-vibrations under impulse input can be derived in a closed form by a sophisticated energy approach without solving directly the equations of motion as differential equations. While, as pointed out above, the approach based on the equivalent linearization method requires the repetition of application of the linearized equations, the method by Kojima and Takewaki does not need any repetition. The double impulse, triple impulse and multiple impulses enable us to describe directly the critical timing of impulses (resonant frequency) which is not easy for the sinusoidal and other inputs without a repetitive procedure. It is important to note that, while most of the previous methods employ the equivalent linearization of the structural model with the input unchanged, the method treated in this eBook transforms the input into a series of impulses with the structural model unchanged. This characteristic guarantees high accuracy and*

reliability even in the large plastic deformation range. The approach presented in this eBook is an epoch-making accomplishment to open the door for simpler and deeper understanding of structural reliability of built environments in the elastic-plastic range

Earthquake Ground Motion and Its Effects on Structures

Critical Earthquake Response of Elastic-Plastic Structures Under Near-Fault or Long-Duration Ground Motions: Closed-Form Approach via Impulse Input

Simple Analysis of Rotational Ground Motions and Their Effects on Structure Displacement

Estimation of Site Effects on Earthquakes Strong Ground Motion in San Diego, California

Effects of Local Geology and Distance from Source on Earthquake Ground Motions

This book discusses the impact of long-period ground motions on structural design using the situation in Bucharest, the capital city of Romania, as a case study. The first part explores the seismic hazard situation in Bucharest, and the causes of long-period ground motions related to both the source and the site. Subsequently, it examines the current seismic design, detailing building practices in Bucharest, and discusses the impact of long-period ground motions on seismic design. Lastly, several case study buildings in Bucharest are presented and the major difficulties encountered in their design are considered. The book also includes various numerical examples that help readers understand the impact of long-period ground motions on various structural systems, that are currently used in Bucharest. This book is intended for researchers in the field of seismic hazard and risk assessment and designers of multi-story buildings in seismic areas.

The best way to minimize damage from earthquakes is to predict their location and effects and reinforce against those possible effects. Toward that end, this book presents prediction methods useful for the design of earthquake-resistant structures. In the first of two parts, the book deals with issues relating to the characterisation and the rational definition of seismic input. It begins with a study of earthquake records that leads to the identification of their damage potential parameters, such as the peak ground acceleration and the strong motion duration. Subsequent chapters concern themselves with the deterministic and probabilistic methodologies for producing seismic inputs. Further chapters are dedicated to the generation of artificial seismic input on the basis of stochastic or probabilistic approaches. The second part of this volume deals with the effects of ground motion on foundation elements and structural integrity. Particular emphasis is given to the interaction of foundation piles with vibrating soils, homogeneous or heterogeneous. The final two chapters are concerned with the possible connection between soil structure interaction (SSI) and structural damage. In both instances records of actual earthquake induced motion are used for such assessments.

This study evaluates the impact, on estimates of seismic risk and its uncertainty, of alternative methods in treatment and characterization of earthquake ground motions. The objective of this study is to delineate specific procedures and characterizations that may lead to less biased and more precise seismic risk results. This report focuses on sources of conservatism and variability in risk that may be introduced through the analytical processes and ground-motion descriptions which are commonly implemented at the interface of seismic hazard and fragility assessments. In particular, implication of the common practice of using a single, composite spectral shape to characterize motions of different magnitudes is investigated. Also, the impact of parameterization of ground motion on fragility and hazard assessments is shown. Examination of these results demonstrates the following. (1) There exists significant conservatism in the review spectra (usually, spectra characteristic of western U.S. earthquakes) that have been used in conducting past seismic risk assessments and seismic margin assessments for eastern U.S. nuclear power plants. (2) There is a strong dependence of seismic fragility on earthquake magnitude when PGA is used as the ground-motion characterization. When, however, magnitude-dependent spectra are anchored to a common measure of elastic spectral acceleration averaged over the appropriate frequency range, seismic fragility shows no important nor consistent dependence on either magnitude or strong-motion duration. Use of inelastic spectral acceleration (at the proper frequency) as the ground spectrum anchor demonstrates a very similar result. This study concludes that a single, composite-magnitude spectrum can generally be used to characterize ground motion for fragility assessment without introducing significant bias or uncertainty in seismic risk estimates.

Ground Motion and Engineering Seismology

Earthquake ground motion and its effects on structures

Earth-science Considerations

Earthquake Scenario Ground Motion Hazard Maps for the San Francisco Bay Region

International Handbook of Earthquake & Engineering Seismology

The two volume International Handbook of Earthquake and Engineering Seismology represents the International Association of Seismology and Physics of the Earth's Interior's (IASPEI) ambition to provide a comprehensive overview of our present knowledge of earthquakes and seismology. This state-of-the-art work is the only reference to cover all aspects of seismology--a "resource library" for civil and structural engineers, geologists, geophysicists, and seismologists in academia and industry around the globe. Part B, by more than 100 leading researchers from major institutions of science around the globe, features 34 chapters detailing strong-motion seismology, earthquake engineering, quake prediction and hazards mitigation, as well as detailed reports from more than 40 nations. Also available is The International Handbook of Earthquake and Engineering Seismology, Part A. Authoritative articles by more than 100 leading scientists Extensive glossary of terminology plus 2000+ biographical sketches of notable seismologists

This breakthrough book is the first to examine the rotational effects in earthquakes, a revolutionary concept in seismology. Existing models do no yet explain the significant rotational and twisting motions that occur during an earthquake and cause the failure of structures. The rotation and twist effects are investigated and described, and their consequences for designing tall buildings and other important

structures are presented. This book will change the way the world views earthquakes.
The dynamic characteristics and torsional behavior of structures during strong ground motion were investigated; both linear and nonlinear material behavior were considered. Emphasis was placed on the strong torsional coupling associated with the beating phenomenon in the seismic response of structures with small static eccentricity and closely spaced frequencies. In order to study the response of structures subjected to complex loading histories, structural models were analyzed through the use of a numerical procedure (Newmark's $beta$ method) combined with a generalized nonlinear material model in the force-displacement space. Parametric studies were made for the dynamic amplification of the torsional response of simple structural systems. An amplification factor of about 2.5 was observed for static eccentricity in structural response arising from earthquake ground excitation. To further comprehend the torsional effects in low-rise structures, two buildings that were extensively instrumented during the 1987 Whittier Narrows Earthquake were analyzed in the light of the seismic requirements in the current building codes. The theoretical demonstration of the beating phenomenon was confirmed by the field recordings in the symmetric steel moment-resisting-frame structure with closely spaced frequencies; similar confirming results were obtained for the other structure. The behavior and response of the two structures were observed to be somewhat different from that envisioned and assumed by the direct design procedure employed by the codes. Some suggestions for improvement in building code provisions are offered.

Reducing earthquake losses

From Source to Fragility

Final Technical Abstract

Report 17 : Interpretation of Strong Ground Motion Records

Assessing the Value of Reduced Uncertainty

Earthquake-induced ground failure, resulting from liquefaction of loose sand and soft clay deposits, has caused tremendous damage to the built and natural environment. Ground failures due to lateral spreading, an effect of soil liquefaction at sites on mildly sloping ground or in close proximity to natural or man-made free faces, has been observed to pose significant risks to bridge pile foundations, underground utilities, and shallow foundation systems. Conventional design guidelines in the United States are typically centered on analysis of the liquefaction triggering limit state, by computing a factor of safety (FSL) that considers a single, probabilistic level of earthquake ground shaking. When compared with fully probabilistic analyses of liquefaction triggering that consider all levels of ground shaking, conventional analyses may result in inconsistent representations of the actual liquefaction hazard in different regions of the U.S. Furthermore, analyses that focus on the triggering limit state, rather than the effects of liquefaction (i.e. ground deformations), are generally insufficient in predicting physical damage and losses, particularly in probabilistic frameworks. In this study, a computational platform for fully probabilistic liquefaction hazard analysis (PLHA) is developed and utilized to evaluate the degree to which conventional liquefaction hazard analyses deviate from the actual liquefaction hazard for the triggering limit state. A comparison study between PLHA-based and conventional estimates of FSL indicates a large degree of inconsistency both at the regional and national scale, with some parts of the U.S. designing for

nearly three times the implied hazard as others when using conventional analyses. To address this inconsistency, a framework is presented for mapping a liquefaction-targeted ground motion intensity measure for a reference soil and site condition, that, in conjunction with site-adjustment factors can be used in conventional analyses to obtain hazard-consistent estimates of FSL. The framework is validated for a range of geographic locations, seismotectonic environments, soil parameters, and site conditions. Finally, recognizing the need to focus on the effects of liquefaction, a large-scale, simulation-based parametric study, consisting of nonlinear finite-element dynamic analyses performed via a high-performance computing platform, is presented for investigating the physical mechanisms that contribute to lateral spreading-type ground failures. The results of this study are used to develop and present a probabilistic framework for predicting post-triggering ground deformations that accounts for the time of liquefaction during during earthquake motions, as well as system-level effects such as the reduction in seismic demands due to liquefaction in deeper soil strata.

Despite advances in the field of geotechnical earthquake engineering, earthquakes continue to cause loss of life and property in one part of the world or another. The Third International Conference on Soil Dynamics and Earthquake Engineering, Princeton University, Princeton, New Jersey, USA, 22nd to 24th June 1987, provided an opportunity for participants from all over the world to share their expertise to enhance the role of mechanics and other disciplines as they

relate to earthquake engineering. The edited proceedings of the conference are published in four volumes. This volume covers: Seismicity and Tectonics in the Eastern Mediterranean, Seismic Waves in Soils and Geophysical Methods, Engineering Seismology, Dynamic Methods in Soil and Rock Mechanics, and Ground Motion. With its companion volumes, it is hoped that it will contribute to the further development of techniques, methods and innovative approaches in soil dynamics and earthquake engineering.

Site and Source Effects on Earthquake Ground MotionEffects of Liquefaction on Earthquake Ground Motions

An Evaluation of Earthquake Ground-motion Site Effects at Two Sites Underlain by Deep Soils in Western Kentucky

Near-fault Ground Motion Estimates Including Directivity Effects from Large Strike-slip Earthquakes in the San Francisco Bay Area

Impact of Long-Period Ground Motions on Structural Design: A Case Study for Bucharest, Romania

Liquefaction-targeted Ground Motion Parameters

State-of-the-art for Assessing Earthquake Hazards in the United States

Fundamentals of Earthquake Engineering: From Source to Fragility, Second Edition combines aspects of engineering seismology, structural and geotechnical earthquake engineering to assemble the vital components required for a deep understanding of response of structures to earthquake ground motion, from the seismic source to the evaluation of actions and deformation required for design, and culminating with probabilistic fragility analysis that applies to individual as well as groups of buildings. Basic concepts for accounting for the effects of soil-structure interaction effects in seismic design and assessment are also provided in this second edition. The nature of earthquake risk assessment is inherently multi-disciplinary. Whereas this book addresses only structural safety assessment and design, the problem is cast in its appropriate context by relating structural damage states to societal consequences and expectations, through the fundamental response quantities of stiffness, strength and ductility. This new edition includes material on the nature of earthquake sources and mechanisms, various methods for the characterization of earthquake input motion, effects of soil-structure interaction, damage observed in reconnaissance missions, modeling of structures for the purposes of response simulation, definition of performance limit states, fragility relationships derivation, features and effects of underlying soil, structural and architectural systems for optimal seismic response, and action and deformation quantities suitable for design. Key features: Unified and novel approach: from source to fragility Clear conceptual framework for structural response analysis, earthquake input characterization, modelling of soil-structure interaction and derivation of fragility functions Theory and relevant practical applications are merged within each chapter Contains a

new chapter on the derivation of fragility Accompanied by a website containing illustrative slides, problems with solutions and worked-through examples Fundamentals of Earthquake Engineering: From Source to Fragility, Second Edition is designed to support graduate teaching and learning, introduce practising structural and geotechnical engineers to earthquake analysis and design problems, as well as being a reference book for further studies.
Site amplification studies and building code provisions recognize that soil liquefaction can alter the characteristics of ground shaking at a site. However, guidance as to how the amplitudes of spectral accelerations are modified is lacking. To address this issue, a two-part study is undertaken. In the first part an empirical study of ground motions recorded at liquefaction sites is undertaken. Available recorded ground motions from shallow crustal earthquakes at sites that exhibited evidence of liquefaction are compiled. Analysis of spectral acceleration residuals of the recorded ground motions computed relative to Next Generation Attenuation (NGA) estimates reveal positive bias at longer periods, slight negative bias at intermediate periods, and slight positive bias at short periods. Trends with Vs30, NGA-estimated peak ground acceleration (PGA), and moment magnitude are also observed. A model is developed that removes the initially observed residual bias and reduces uncertainty. The proposed model can be used to adjust NGA-estimated acceleration response spectra to account for

the effects of liquefaction on ground shaking. In the second part of this study a series of parametric 1-D site response analyses were performed to provide a much larger synthetic dataset and to study geotechnical parameter that are typically unavailable in the empirical data. An existing constitutive model was rigorously calibrated against a widely-used semi-empirical liquefaction triggering method. The calibrated model was used to perform 2988 site response analysis pairs : one with porewater pressure generation and the other without. The resulting surface spectra are compared in a way that is analogous to the empirical study. Liquefaction amplification factors from the site response analysis results exhibit similar trends with period compared to the empirical data, but their amplitudes are systematically lower. The differences might be attributable to the inability of the 1-D site response analyses to capture 2-D and 3-D effects such as surface waves and basin effects, or possibly shortcomings the in the 1-D model's ability to faithfully represent all salient aspects of 1-D wave propagation under liquefaction conditions. Factors that appear to influence liquefaction amplification the most include whether the input motion is pulse-like or not and the amplitude of ground shaking.

Improved Seismic Monitoringâ€"Improved Decision-Making, describes and assesses the varied economic benefits potentially derived from modernizing and expanding seismic monitoring activities in the United States. These benefits include more effective loss avoidance regulations and strategies, improved understanding of earthquake processes, better engineering design, more effective hazard mitigation strategies, and improved emergency response and recovery. The economic principles that must be applied to determine potential benefits are reviewed and the report concludes that although there is insufficient information available at present to fully quantify all the potential benefits, the annual dollar costs for improved seismic monitoring are in the tens of millions and the potential annual dollar benefits are in the hundreds of millions.

Improved Seismic Monitoring - Improved Decision-Making

From Seismology to Analysis and Design

Seismic Ground Motion in Large Urban Areas

Effects of Earthquake Rupture Shallowness and Local Soil Conditions on Simulated Ground Motions

Fundamentals of Earthquake Engineering

The accelerated, and often uncontrolled, growth of the cities has contributed to the ecological transformation of their immediate surroundings. Factors contributing to the urban vulnerability include: lowering or rising of the water table, subsidence, loss of bearing capacity of soil foundations and instability of slopes. Recent catastrophic earthquakes highlight the poor understanding by decision makers of seismic related risk, as well as the tendency of some

builders to use the cheapest designs and construction materials to increase short-term economic returns on their investment. Losses from earthquakes will continue to increase if we do not shift towards proactive solution. Disaster reduction is both an issue for consideration in the sustainable development agenda and a cross-cutting issue relating to the social, economic, environmental and humanitarian sectors. As location is the key factor, which determines the level of risk associated with a hazard, land-use plans and mapping should be used as tools to identify the most suitable usage for vulnerable areas.

This study investigates the effects of style of faulting on earthquake ground motion in New Madrid seismic zone (NMSZ). I undertake a detailed analysis of local waveform data using a multistage processing method to produce empirical attenuation relations for frequencies between 1 and 16 Hz. The dataset consists of 854 local events of magnitude 1.6M

Earthquakes have caused massive death and destruction, and potentially damaging earthquakes are certain to occur in the future. Although earthquakes are uncontrollable, the losses they cause can be reduced by building structures that resist earthquake damage, matching land use to risk, developing emergency response plans, and other means. Since 1977, the federal government has had a research oriented program *to reduce earthquake losses the National Earthquake Hazards Reduction Program (NEHRP). This program has made significant contributions toward improving our understanding of earthquakes and strategies to reduce their impact. Implementing action based on this understanding, however, has been quite difficult. This chapter provides an introduction to earthquakes: a sum mary of the earthquake hazard across the United States, a review of the types of losses earthquakes cause, a discussion of why earthquakes are a congressional concern, and an introduction to mitigation actions taken prior to earthquakes that can reduce losses when they occur. The federal policy response to date, NEHRP is then described and reviewed. Finally, specific policy options for improving federal efforts to reduce future earthquake losses are presented.*

An Empirical Interpretation of the Effects of Topography on Ground Motion of the San Fernando, California, Earthquake, 9 February 1971

Semi-annual [i.e. Final] Technical Report to the U.S. Geological Survey, 1 January 1978-30 June 1978

Critical Aspects of Earthquake Ground Motion and Building Damage Potential

Effects of Liquefaction on Earthquake Ground Motions

This study attempts to determine site effects on earthquake ground motion and the correlation between acceleration and/or velocity generated during the San Fernando Earthquake and topography of the San Gabriel Mountain range. It was found that the contours of peak acceleration and peak velocity generally follow the topography of the San Gabriel Mountain range. The topographical effects on the ground motion could be interpreted in a simple manner as a function of elevation and direction of wave transmission path. The elevation and direction become the dominant factors in the distribution of the ground motion in the near field. A simple, practical method for calculating the bedrock motion using the ground motion-elevation gradient has been applied in the area south of Kagel Mountain and north of Santa Monica Mountain, in the San Fernando Valley. This method is validated using after-shock data. This ground motion-elevation gradient method was applied to an area where the topography has its highest elevation at the epicentral region and decreases in elevation to the surrounding locations in the near field (within 30 km). In any case, when the epicenter occurs at an elevation lower than the elevation of the surrounding area, this gradient method may not be applicable and must be tested for this alternate condition. 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.

In attempts to extend the usual seismological analyses of seismograms to strong-motion records. A description is given of the main patterns of motions recorded on accelerograms near to the causative fault in terms of P and S waves and Love and Rayleigh waves. In order to achieve this, the effects of source dimensions and the physical and kinematic properties of the fault zone are included in the analysis. The two main aims of the work were, first, to make an initial step toward the routine interpretation of the recorded strong ground motions and, as a consequence, to provide a basis which would allow ground motions in future large earthquakes to be predicted. Both aspects of strong -motion seismology are of interest to the engineering profession for the design of critical structures in earthquake country. The research has been based on the detailed study of near-field records obtained in moderate to large earthquakes in the last few decades. In particular, analysis is made of strong-motion records of 10 important earthquakes that includes: the 1952 Kern County, CA, earthquake; the 1971 San Fernando, CA, earthquake; the 1972 Managua, Nicaragua, earthquake; the 1977 Romania earthquake; the 1979 Imperial Valley, CA, earthquake; and the 1980 Livermore Valley, CA, earthquake. The analysis works from first physical principles and, so far as possible, uses elementary ray theory and kinematic arguments. Nevertheless, elements of the more sophisticated theory of earthquake mechanisms and seismic wave propagation in the near field were taken into account in the interpretative work.

Statistical Analysis of Earthquake Ground Motion Parameters

Earthquake Source Asymmetry, Structural Media and Rotation Effects

ground motion and its effects on structures ; presented at the Winter Annual Meeting, ASME, Phoenix, Ariz., November 14 - 19, 1982

Symposium : Winter annual meeting : Papers

Why Do Buildings Collapse in Earthquakes? Building for Safety in Seismic Areas

This book contains selected papers presented at the NATO Advanced Study Institute on "Strong Ground Motion Seismology", held in Ankara, Turkey between June 10 and 21, 1985. The strong ground motion resulting from a major earthquake determines the level of the seismic hazard to enable earthquake engineers to assess the structural performance and the consecutive risks to the property and life, as well as providing detailed information to seismologists about its source mechanism. From the earthquake engineering point the main problem is the specification of a design level ground motion for a given source-site-structure-economic life and risk combination through deterministic and probabilistic approaches. In seismology the strong motion data provide the high frequency information to determine the rupture process and the complexity of the source mechanism. The effects of the propagation path on the strong ground motion is a research area receiving sub stantial attenuation both from earthquake engineers and seismologists. The Institute provided a venue for the treatment of the subject matter by a series of lectures on earthquake source models and near field theories; effects of propagation paths and site conditions, numerical and empirical methods for prediction; data acquisition and analysis; hazard assessment and engineering application.

This book provides senior undergraduate students, master students and structural engineers who do not have a background in the field with core knowledge of structural earthquake engineering that will be invaluable in their professional lives. The basics of seismotectonics, including the causes, magnitude, and intensity of earthquakes, are first explained. Then the book introduces basic elements of seismic hazard analysis and presents the concept of a seismic hazard map for use in seismic design. Subsequent chapters cover key aspects of the response analysis of simple systems and building structures to earthquake ground motions, design spectrum, the adoption of seismic analysis procedures in seismic design codes, seismic design principles and seismic design of reinforced concrete structures. Helpful worked examples on seismic analysis of linear, nonlinear and base isolated buildings, earthquake-resistant design of frame and frame-shear wall systems are included, most of which can be solved using a hand calculator.

Torsional Effects in Low-rise Structures Subjected to Earthquake Ground Motion

Ground Motions and Soil Liquefaction During Earthquakes

Torsional Effects in Structures Subjected to Strong Ground

Motion

Analysis of Strong Motion Data and the Effects of Earthquake Source Parameters on Ground Motion in California

Facing Geologic and Hydrologic Hazards