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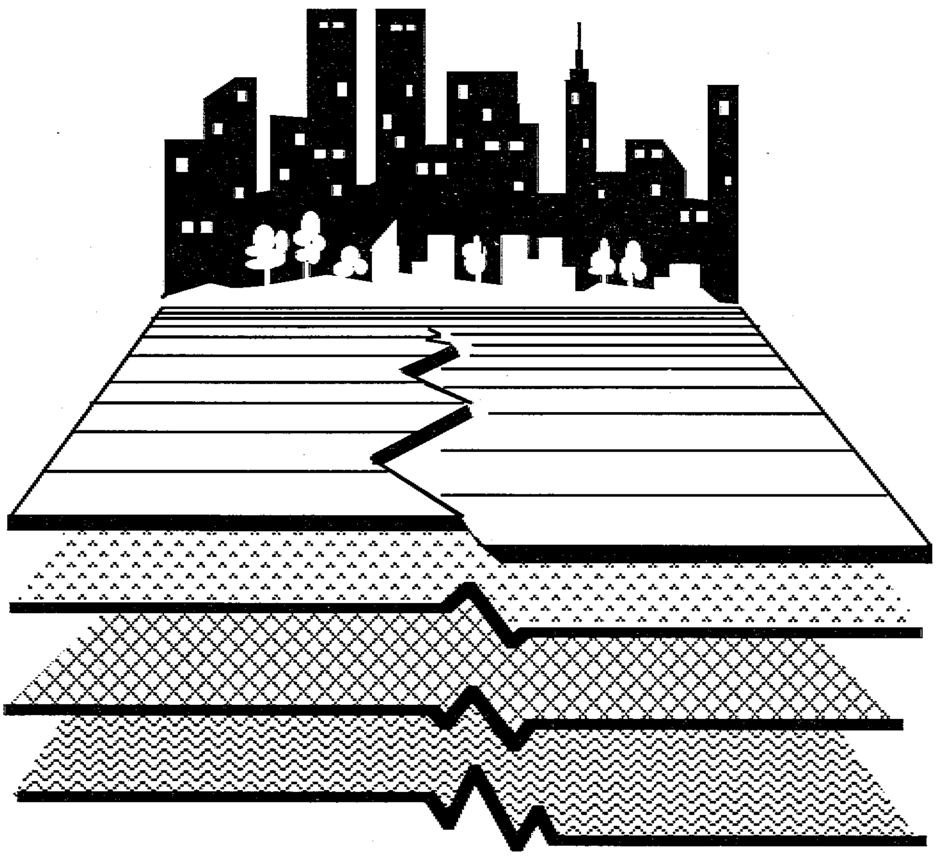
Planning for Seismic Rehabilitation: Societal Issues



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BUILDING SEISMIC SAFETY COUNCIL

Of the National Institute of Building Sciences

Program on Improved Seismic Safety Provisions

PLANNING FOR SEISMIC REHABILITATION: SOCIETAL ISSUES

FEMA 275

The **Building Seismic Safety Council** (BSSC) was established in 1979 under the auspices of the National Institute of Building Sciences as an entirely new type of instrument for dealing with the complex regulatory, technical, social, and economic issues involved in developing and promulgating building earthquake hazard mitigation regulatory provisions that are national in scope. By bringing together in the BSSC all of the needed expertise and all relevant public and private interests, it was believed that issues related to the seismic safety of the built environment could be resolved and jurisdictional problems overcome through authoritative guidance and assistance backed by a broad consensus.

The BSSC is an independent, voluntary membership body representing a wide variety of building community interests. Its fundamental purpose is to enhance public safety by providing a national forum that fosters improved seismic safety provisions for use by the building community in the planning, design, construction, regulation, and utilization of buildings.

To fulfill its purpose, the BSSC: (1) promotes the development of seismic safety provisions suitable for use throughout the United States; (2) recommends, encourages, and promotes the adoption of appropriate seismic safety provisions in voluntary standards and model codes; (3) assesses progress in the implementation of such provisions by federal, state, and local regulatory and construction agencies; (4) identifies opportunities for improving seismic safety regulations and practices and encourages public and private organizations to effect such improvements; (5) promotes the development of training and educational courses and materials for use by design professionals, builders, building regulatory officials, elected officials, industry representatives, other members of the building community, and the public; (6) advises government bodies on their programs of research, development, and implementation; and (7) periodically reviews and evaluates research findings, practices, and experience and makes recommendations for incorporation into seismic design practices.

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Developed for the Building Seismic Safety Council by ROA (Robert Olson Associates, Inc.) with the support of the Federal Emergency Management Agency

BUILDING SEISMIC SAFETY COUNCIL
of the National Institute of Building Sciences
Washington, D.C.
1998

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This report was prepared under Cooperative Agreement EMW-91-K-3602 between the Federal Emergency Management Agency and the National Institute of Building Sciences.

Building Seismic Safety Council activities and products are described at the end of this report. For further information, contact the Building Seismic Safety Council, 1090 Vermont, Avenue, N.W., Suite 700, Washington, D.C. 20005; phone 202-289-7800; fax 202-289-1092; e-mail bssc@nibs.org. Copies of this report may be obtained by contacting the FEMA Publication Distribution Facility at 1-800-480-2520.

FOREWORD

In 1984, the Federal Emergency Management Agency (FEMA) initiated a comprehensive, and closely coordinated program to develop a body of knowledge in support of building practices that would increase the ability of existing buildings to withstand the forces of earthquakes. Societal issues inherent in seismic rehabilitation processes also have received attention. At a cumulative cost of about $26 million, this FEMA effort has generated two dozen publications and a number of software programs and audio-visual training materials for use by design professionals, building regulatory personnel, educators, researchers, and the general public. The program has proceeded along separate but parallel approaches in dealing with both private sector and federal buildings.

Already available from FEMA to private sector practitioners and other interested parties is a "technical platform" of consensus criteria on how to deal with some of the major engineering aspects of the seismic rehabilitation of buildings. Completed in 1992, this technical material comprises a trilogy with supporting documentation: a method for the rapid identification of buildings that might be hazardous in an earthquake and which can be conducted without gaining access to the buildings themselves; a methodology for a more detailed evaluation of a building that identifies structural flaws that have caused collapse in past earthquakes and might do so again in future earthquakes, and a compendium of the most commonly used techniques of seismic rehabilitation.

Along with this volume, the culminating activity in the field of seismic rehabilitation is the completion of a comprehensive set of nationally applicable guidelines with commentary on how to rehabilitate buildings so that they will better withstand earthquakes. Known as the *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* (FEMA 273) and the *Commentary on the Guidelines for the Seismic Rehabilitation of Buildings* (FEMA 274), these volumes, the results of a multiyear, multimillion dollar effort, represent a first of its kind in the United States. The *Guidelines* allow practitioners to choose design approaches consistent with different levels of seismic safety as required by geographic location, performance objective, type of building, use or occupancy, or other relevant considerations. The *Guidelines* documents also include analytical techniques that will assist in generating reliable estimates of the expected earthquake performance of rehabilitated buildings. This extensive platform of materials fills a significant gap in that portion of the National Earthquake Hazards Reduction Program (NEHRP) focusing on the seismic safety of existing buildings.

The *Guidelines* documents were given consensus review by representatives of a broad spectrum of users including the construction industry; building designers; building regulatory organizations; building owners and occupant groups; academic and research institutions; financial establishments; local, state, and federal levels of government; and the general public. This process helped to ensure the national applicability of the *Guidelines* documents and encourage widespread acceptance and use by practitioners. It is expected that, with time, the *Guidelines* will be referenced or adapted by standards-setting groups and model building code organizations and will thereby diffuse widely into building practices across the United States.

This volume complements the technical materials principally oriented to design professionals in the *Guidelines* documents. Because of the complexities and possible disruption caused by seismic rehabilitation projects, this volume's title, *Planning for Seismic Rehabilitation: Societal Issues*, calls attention to two important themes: that careful planning can minimize possibly difficult societal problems and that there exists a wide range of societal issues that may be more significant in rehabilitation projects than in new construction. In many ways, this publication is intended to provide a "heads up" to those who are considering individual or multiple building, construction class or use, or area-focused seismic rehabilitation efforts.

This volume exploring societal issues reflects very generous contributions of time and expertise on the part of many individuals, contributions that are warmly acknowledged. FEMA is particularly grateful for the efforts of the BSSC and its consultant Robert Olson, the Project Oversight Committee, and the BSSC Project Committee and Seismic Rehabilitation Advisory Panel.

Federal Emergency Management Agency

PREFACE and ACKNOWLEDGMENTS

In August 1991, the National Institute of Building Sciences (NIBS) entered into a cooperative agreement with the Federal Emergency Management Agency (FEMA) for conduct of a comprehensive seven-year program leading to the development of a set of nationally applicable guidelines for the seismic rehabilitation of existing buildings. Under this agreement, the Building Seismic Safety Council (BSSC) served as program manager with the American Society of Civil Engineers (ASCE) and the Applied Technology Council (ATC) working as subcontractors. Initially, FEMA provided funding for a program definition activity designed to generate the detailed work plan for the overall program. The work plan was completed in April 1992 and in September FEMA contracted with NIBS for the remainder of the effort.

The major objectives of the project were to develop a set of technically sound, nationally applicable guidelines (with commentary) for the seismic rehabilitation of buildings; to achieve building community consensus regarding the guidelines; and to structure the basis of a plan for stimulating widespread acceptance and application of the guidelines. The technical guidelines documents produced as a result of this project—the *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* (FEMA 273) and its *Commentary* (FEMA 274)—are intended to serve as a primary resource on the seismic rehabilitation of buildings for the use of design professionals, educators, model code and standards organizations, and state and local building regulatory personnel.

As noted above, the project work involved the ASCE and ATC as subcontractors as well as groups of volunteer experts and paid consultants, and it was structured to ensure that the technical guidelines writing effort benefited from consideration of: the results of completed and ongoing technical efforts and research activities; societal issues, public policy concerns, and the recommendations presented in an earlier FEMA-funded report on issues identification and resolution; cost data on application of rehabilitation procedures; the reactions of potential users; and consensus review by a broad spectrum of building community interests.

While overall management has been the responsibility of the BSSC, responsibility for conduct of the specific project tasks was shared by the BSSC with ASCE and ATC. Specific BSSC tasks were completed under the guidance of a BSSC Project Committee. To ensure project continuity and direction, a Project Oversight Committee (POC) was responsible to the BSSC Board of Direction for accomplishment of the project objectives and the conduct of project tasks. Further, a Seismic Rehabilitation Advisory Panel reviewed project products as they developed and advised the POC on the approach being taken, problems arising or anticipated, and progress made. Three user workshops also were held during the course of the project to expose the project and various drafts of the *Guidelines* documents to review by potential users of the ultimate project product.

The final drafts of the *Guidelines* and its *Commentary* were submitted to the BSSC member organizations for balloting in October-December 1996 and June-July 1997. The final versions of the consensus-approved documents were transmitted to FEMA for publication in September 1997.

This document was developed for the Building Seismic Safety Council by ROA (Robert Olson Associates, Inc.) to serve as an additional resource to provide those considering seismic rehabilitation with insights into the complex economic, social, and political issues surrounding such efforts. The BSSC is grateful to Mr. Olson for sharing his professional expertise and participating throughout the project.

The BSSC also wishes to acknowledge the wide variety of groups that provided Mr. Olson with helpful contributions and suggestions. Special appreciation is extended to the members of the BSSC Project Committee and Seismic Rehabilitation Advisory Panel, the participants in the users' workshops held during the *Guidelines* development effort, and the Advisory Committee on Social and Policy Issues formed for this project by the Earthquake Engineering Research Institute—all of whom provided valuable advice and comments (see Appendix B for committee/panel membership lists). The BSSC also

wishes to acknowledge the efforts of Ugo Morelli, FEMA Project Officer, and his technical advisor, Diana Todd, both of whom provided thoughtful and constructive suggestions during that have immeasurably improved the products of the project.

It should be noted that recommendations resulting from the concept work of the BSSC Project Committee have resulted in initiation of a case studies project that will focus on the development of seismic rehabilitation designs for over 40 buildings selected from an inventory of buildings determined to be seismically deficient under the implementation program of Executive Order 12941 and determined to be considered "typical of existing structures located throughout the nation."

Feedback from those reading this *Societal Issues* volume and using the *Guidelines* documents outside the case studies project is strongly encouraged. Further, the curriculum for a series of education/training seminars on the *Guidelines* is being developed and a number of seminars are scheduled for conduct in 1998. Those who wish to provide feedback or with a desire for information concerning the seminars should direct their correspondence to: BSSC, 1090 Vermont Avenue, N.W., Suite 700, Washington, D.C. 20005; phone 202-289-7800; fax 202-289-1092; e-mail bssc@nibs.org.

Eugene Zeller, BSSC Chair

EXECUTIVE SUMMARY

Those involved in the complex process of preparing the *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* and its *Commentary* (referred to in this publication as the *Guidelines* or the *Guidelines* documents) recognized from the outset the importance of helping users deal with the social, economic, and public policy complexities of rehabilitation. Indeed, the Executive Director of the Building Seismic Safety Council, the managing organization for this project, noted that seismic rehabilitation decision-makers "possibly are not technically oriented but will have to say yea or nay on incorporating information from the *Guidelines* into local practices, be they business or regulatory."

This *Societal Issues* volume has been prepared to acquaint potential users of the *Guidelines* documents with typical problems unrelated to design and construction processes that might arise when planning or engaging in seismic rehabilitation projects and programs. Further, it is intended to alert readers to the difficulties inherent in implementing seismic rehabilitation recommendations.

The goals of seismic rehabilitation are important. They include, above all, protecting life and property in future earthquakes as well as protecting investments, lengthening a building's usable life, reducing demands on post-earthquake search and rescue resources, protecting historic structures, shortening business interruption time, maintaining inventories and customers, and reducing relocation needs/demands. Other worthy goals include limiting the need for post-earthquake emergency shelter and temporary housing, minimizing the release of hazardous substances, conserving natural resources, avoiding the costly processes of settling insurance claims and applying for post-disaster aid, protecting savings and contingency funds, reducing the amount of debris to be removed, and facilitating an earthquake-stricken community's return to normal patterns of activity.

This publication is structured to emphasize two basic user-oriented concepts. The first is a four- step iterative process that outlines a set of decision points so the user can determine whether seismic rehabilitation efforts are needed and, if so, their potential scope. The second offers a simple "escalation ladder" to help users understand the degree of conflict inherent in and the implications of choosing what, if any, seismic rehabilitation strategies to follow.

The four-step decision process includes:

- Defining the problem by conducting preliminary and, if needed, detailed analyses of the risk;
- Developing and refining the alternatives for addressing seismic rehabilitation;
- Adopting an approach and an implementation strategy; and
- Securing the needed resources and implementing the seismic rehabilitation measures.

The strategies available to those who become involved with seismic rehabilitation will reflect the mixture of private efforts and governing public policies existing in the specific context (e.g., a city). Attrition is one choice and has the least conflict. A second choice is purely voluntary rehabilitation, but even this approach may engender some conflict as government becomes involved in the permitting process. The third choice involves a more proactive role of government and, therefore, a potentially higher level of conflict; it entails informally encouraging owners to rehabilitate their buildings by establishing some standards and triggers and then negotiating the scope of work on a case-by-case basis as a condition of being granted the necessary permits. The fourth and final strategic choice and the one with the highest degree of conflict centers on government mandation of seismic rehabilitation—i.e., the establishment of seismic rehabilitation ordinances defining which types or uses of buildings require rehabilitation, the applicable standards, reporting and inspection requirements, time frames for compliance, and penalties for not doing so.

In recognition of the fact that each building is unique, this publication also examines the wide spectrum of socioeconomic issues that may face those involved in seismic rehabilitation efforts. Each is discussed in terms of the nature of the problem, typical issues, and some example solutions. Considered are problems related to historic properties, the distribution of economic impacts, occupant dislocation, business interruption, effects on the housing stock, rehabilitation triggers, financing rehabilitation, legal concerns, and selection of rehabilitation targets.

Inasmuch as the intended users of the *Guidelines* documents and this publication are most likely to be local building and planning officials, private owners and consulting design professionals, three illustrative "application scenarios" are presented. Each scenario presents a situation (for a private company facilities manager; a local government city manager and building official; and a consulting engineer) and a list of considerations that would commonly have to be addressed.

The economic, social, and political complexities and the varying seismic environments of the United States are such that seismic rehabilitation programs will have to be tailored to thousands of individual situations. This publication therefore provides an extensive reference section to help the reader locate additional applicable materials.

CONTENTS

Chapter 1
WHY SEISMIC REHABILITATION?

WHY REHABILITATION?

The core argument for the seismic rehabilitation of buildings is that rehabilitated buildings will provide increased protection of life and property in future earthquakes, thereby resulting in fewer casualties and less damage than would otherwise be the case. It is a classic mitigation strategy not unlike preventive medicine. On the human level, more earthquake-resistant buildings will mean fewer deaths and injuries in an event and therefore lower demand on emergency medical services, urban search and rescue teams, fire and law enforcement personnel, utilities, and the providers of emergency shelter. In the commercial sector, less damage to structures will mean enhanced business survival and continued ability to serve customers and maintain markets or market shares. More specifically, for commercial enterprises seismic rehabilitation will better protect physical and financial assets; reduce inventory loss; shorten the business interruption period; avoid the need for relocation; and minimize secondary effects on suppliers, shippers, and other businesses involved in support services or product cycles. For governments, less damage to government structures will mean continued services and normal processes or at least minimal interruptions. If government structures come through an earthquake with little or no damage, agencies will not have to relocate services, and public officials can respond to the immediate and long-term demands placed on them by the event. In short, seismic rehabilitation as a pre-event mitigation strategy actually will improve post-event response by lessening life loss, injury, damage, and disruption.

Seismic rehabilitation also will help achieve other important goals, that contribute to business and community well-being. For example, seismic rehabilitation will::

- Reduce community economic and social impacts (e.g., less loss of employment and increased blighted areas resulting from an earthquake and less loss of tax revenues to support public services).
- Minimize the need for and the process management time required to obtain disaster assistance as well as the financial impacts of filing insurance or disaster assistance claims, seeking loans or grants, and liquidating savings or contingent reserves.
- Help to protect historic buildings, structures, or areas that represent unique community values and that provide the residents with a sense of their unique histories.
- Minimize impacts on such critical community services as hospitals and medical care facilities, whether or not such services are provided by private, nonprofit, or government entities.
- Support the community's post-earthquake need to return to a pattern of normal activities by helping to ensure the early reopening of business and civic facilities (e.g., functioning schools, stores, and government offices). In addition to reducing demands for immediate assistance, such as providing emergency shelter and food, restoring normal activities as soon as possible contributes greatly to the psychological well-being of a community – e.g., children return to school, parents return to work, businesses reopen, and links with the broader "outside world" are restored.
- Minimize the many and often subtle direct and indirect socioeconomic impacts of earthquakes, some of which emerge slowly but often last a long time. For example, after a disaster, low-income residents often become displaced which adds to any existing homeless problem and increases the burden on community services and charitable organizations, often reducing their abilities to provide regular services. Further, marginal businesses may not be able to reopen, thus weakening a community's economic and social fabric and reducing tax revenues, which may result in a shift in the tax structure to pay for public services. Finally, the distribution of impacts may mean that adjacent areas gain at the expense of the damaged areas.

- Reduce the difficult environmental impacts of earthquakes. These include, for example, the need to dispose of large quantities of debris, the release of asbestos in damaged buildings, and the contamination of the air and water with spilled hazardous materials.

In sum, the rehabilitation of existing buildings to better resist future damaging earthquakes truly is "preventive medicine." While seismic rehabilitation costs money, it can significantly reduce future losses and, in economic terms, can be considered an investment to protect assets currently at risk. Emergency response capabilities, as good as they are in U.S. communities, are no substitute for amelioration of the direct and indirect losses to each citizen's physical assets and each community's infrastructure.

WHAT FOLLOWS?

Completing this *Societal Issues* volume are five additional chapters plus an appendix to help the reader achieve the multiple goals of seismic rehabilitation.

Chapter 2 provides a decision-making guide to support the analysis and implementation of efforts to seismically strengthen buildings. Chapter 3 describes the broad context in which seismic rehabilitation occurs, explains how different approaches involve various complexities and degrees of conflict, and provides guidance and case study examples of various approaches and tactics to achieve seismic rehabilitation. Chapter 4 examines a wide range of typical societal problems and explores various ways of addressing them. Chapter 5 presents three application scenarios designed to help the user understand his or her situation and the factors that may be involved in initiating a seismic rehabilitation effort. Chapter 6 points the reader toward some of the socio-economic literature related to seismic rehabilitation while the Appendix provides a detailed discussion of the four-step process for solving problems. The report concludes with an overview of the purpose and activities of the Building Seismic Safety Council and a list of those involved in the *Guidelines* project.

Chapter 2
A DECISION-MAKING GUIDE

INTRODUCTION

While the seismic rehabilitation of existing buildings presents many of the same challenges to private as well as public sector decision-makers, this publication is intended primarily for local government officials, especially those in planning, redevelopment and building departments, and public agency and private engineers who find themselves involved in the public policy aspects of seismic rehabilitation.

Despite the fact that each building has "its own story" when it comes to seismic rehabilitation, similar public policy issues reappear so often that providing a generalized approach to achieving seismic rehabilitation is possible. Therefore, a generic, four-step process is outlined for use primarily by local government officials as well as, building owners, engineers, and/or private consultants seeking approval from local governments to seismically rehabilitate a building or group of buildings.

Secondarily, this publication is directed toward private-sector decision-makers. The term "private sector" is admittedly quite broad, encompassing the owner of one office building in a small city in a low seismic risk (and awareness) zone, the owner of multiple-unit apartment buildings in a zone of moderate risk (and awareness), a large corporation with facilities in high seismic risk (and awareness) zones, and all those in between.

Nonetheless, despite obviously different contexts and specific problems, the shared nature of the earthquake-vulnerable structure problem establishes certain commonalities between the private and public sectors. Although some parts of this publication may be more relevant than others, the hope is that it will be useful to corporate facility managers who wish to seismically rehabilitate a building or group of buildings and must secure appropriate approvals and support from chief executive officers, boards of directors, or clients. It is important to note, however, that the engineering expertise of a design professional (architect, engineer, code official) is a prerequisite to the appropriate use of the *Guidelines* documents.

It should be noted that even if community or private-sector decision-makers responsible for one or more types of earthquake-vulnerable structures anticipate and address the social, economic, and political complications inherent in seismic rehabilitation, the problems will not be eliminated. This approach will, however, facilitate their management. In addition, effectively managing the human or nontechnical problems of seismic rehabilitation hopefully will make the use of the separate but companion engineering publications, the *Guidelines* documents, more tailored and therefore more sensitive to particular situations and environments.

AN OVERVIEW OF THE FOUR-STEP PROCESS

A common four-step problem-solving process follows:

1. Defining the problem

    1A. Conducting preliminary analysis

    1B. Conducting detailed analysis (+ feedback)

2. Developing and refining alternatives (+ feedback)
3. Adopting an approach and implementation strategy (+ feedback)
4. Securing resources and implementing (+ feedback)

As in many processes of this type, this generic four-step model emphasizes the feedback function at every step because no existing building seismic rehabilitation effort can possibly succeed in isolation, no matter how splendid the technical components. Seismic rehabilitation takes place in a wide variety of socioeconomic and political contexts, and continuous feedback and adjustments are necessary for success. The number of affected buildings, the acceptable level of risk defined by the selected rehabilitation performance objectives, the duration of the program, the cost, and the social and economic impacts are interdependent. By the very number and nature of the variables, seismic rehabilitation decision-making is very complex for it must balance so many considerations.

The level of detail, amount of data collected, degree of analysis, formality of procedures, and resources committed will vary with the intended use of the engineering publications (the *Guidelines* documents) and with the conditions and circumstances faced by the reader. As a result, given differing community, jurisdictional or corporate contexts, each reader must determine the extent of data collection and analysis of alternatives needed. In other words, each step constitutes a kind of progressive discovery leading to a better understanding of the issues. Each step tests whether the seismic risk justifies the cost and effort involved in taking the next step. Thus, the process is essentially iterative with the steps building on assumptions and estimates of the nature and scope of potential problems and then allowing expansion and refinement of the approach.

Step 1, "Defining the Problem," actually comprises two substeps: "preliminary analysis"and "detailed analysis." Preliminary analysis (Step 1A) entails an initial and perhaps even cursory survey of the general issues raised by an identified earthquake threat. Because earthquake-induced life and property losses tend to be concentrated in building types already known to be vulnerable, once a relatively specific degree of seismic risk and likely consequences have been identified, the issue of seismic rehabilitation arises almost immediately. Therefore, the product of Step 1A is simply a good enough understanding of the seismic risk, the possible scope of potential building rehabilitation efforts, and the implications of such rehabilitation for owners, occupants, and the community so that an informed decision to proceed or not proceed can be made. If a decision is made to proceed, Step 1B, detailed analysis, defines more precisely the nature of the risk and the problem through:

1. Collection of data on the physical nature and policy implications of possible target buildings
2. Refinement and expansion of the initial understanding,
3. Definition of the specific problems and impacts, and
4. Identification of the people and organizations potentially affected by rehabilitation.

The product of Step 1B is a decision to proceed or not proceed given consideration of alternatives and the impact of the decision.

Step 2, "Develop and Refine Alternatives," involves using the data assembled under Step 1B to develop and refine alternative approaches that address the seismic rehabilitation of existing buildings in light of the risk, the costs, and the social and economic impacts. Thus, Step 2 provides a kind of "menu" delineating seismic rehabilitation options for communities in various risk situations. Step 2 usually is a very long and involved process, but the key variables always are the desired performance levels, the scope of the approach, and an estimate of the costs. The first determines how much rehabilitation needs to be accomplished; the second determines how many buildings of what type and use are to be subject to rehabilitation; and the third estimates the cost of each alternative. The outcome of Step 2 is a recommendation, usually from a facilities manager or building official, to the next-level decision-maker(s) on a particular approach to seismic rehabilitation. For public entities, an environmental impact report may be required as part of this step.

Step 3, "Adopt an Approach and Implementation Strategy," is the decision point at which the city or county council, chief executive officer, board, building owner, agency director, or whoever is charged with the final responsibility considers the rehabilitation recommendation, receives input from other sources, and weighs the alternatives (not to be ignored is the alternative of doing nothing). Fundamentally, the decision to act on, modify, or reject a seismic rehabilitation plan is a political decision, whether made by government or a private-sector body. It is a decision that allocates scarce resources, costs, and benefits. It determines who benefits, who pays how much and when, and who bears the indirect costs (e.g., employees, tenants, suppliers,). Finally, the decision to act sets in motion the necessary organizational routines to actually yield activity, in this case seismic rehabilitation.

Step 4, "Secure Resources and Implement," is the critical process that turns a decision to rehabilitate into its physical result--safer, more seismically resistant buildings. Without resources (personnel, budget) to carry out seismic rehabilitation, the adoption of an approach is simply "a piece of paper." In addition, even when the necessary resources are allocated, implementation may be quite extended depending upon the number of buildings slated for rehabilitation, and feedback is perhaps more important here than in any other step. Whoever is charged with overseeing the seismic rehabilitation must be kept apprized of any new techniques or standards that might alter the approach. In addition, the program manager must provide for quality control and must monitor and mitigate, to the extent possible, both the anticipated and the unanticipated socioeconomic and political side effects of seismically rehabilitating buildings.

Chapter 3
SEISMIC REHABILITATION IN CONTEXT

EACH BUILDING HAS ITS OWN STORY

Earthquake-vulnerable buildings exist nationwide, but the earthquake hazard is not uniform across the country. Moreover, awareness of th earthquake hazard, the precursor to any action, varies even more than the hazard itself. Therefore, tackling the earthquake-vulnerable building problem takes place in an incredibly diverse set of geographic, social, economic, and political environments. Further complicating the situation is the fact that no two buildings (even within the same jurisdiction) ever seem to present exactly the same problems. Each building has its own earthquake-vulnerability profile — location, architecture, structural system, occupancy, economic role, and financing. In other words, each building has its own story.

In sum, while few would quibble with the general legitimacy of a policy whose goal is the seismic rehabilitation of earthquake-vulnerable buildings, seismic rehabilitation will be achieved on a city-by-city and, actually, on a building-by-building basis. Such is life in a continent-sized nation with a federal governmental system. The intent of this chapter is to place and explain seismic rehabilitation in various socioeconomic and political contexts and to offer a set of approaches or "models" to inform and guide action.

LOOK BEFORE REHABILITATING

In point of fact, if you are reading this document, you most likely are already beyond what is known in policy analysis as the "problem recognition stage." Precisely because you are reading this volume and presumably the *Guidelines* documents, you are aware of buildings that may be seismically unsafe and you wish, or feel compelled, to do something about the threat. In other words, you are already aware that a problem may exist, and you want to learn more about how to solve it.

It merits noting that the *Guidelines* documents represent a federally funded engineering innovation in earthquake safety and are designed for use in a wide variety of settings. Overall, the purpose of the *Guidelines* documents is to help you with the technical aspects of actually accomplishing seismic rehabilitation. This volume, however, explores the non-technical factors involved in seismic rehabilitation.

Precisely because seismic rehabilitation is not a purely technical process, an often bewildering array of problems and complexities arise. Abating the risk posed by earthquake-hazardous buildings often brings into play social, economic, psychological, and various other considerations that make seismic rehabilitation very complex and, in those situations involving compliance with governmental seismic rehabilitation requirements, quite political.

SEISMIC REHABILITATION AND PUBLIC VALUES

By standard definition, politics is all about "the authoritative allocation of values" or, as one scholar put it, politics is "who gets what, when, and how." Politics, therefore, is an arena of conflict, cooperation, and compromise in which a pluralistic/democratic society, or a constituting jurisdiction, determines how and by whom a particular problem is identified, defined, addressed, and resolved — and then at what and whose cost. Given that seismic rehabilitation is really about "life safety," a central value if ever there was one, it often becomes political. Following directly from this observation, four points should be kept in mind:

First, seismic rehabilitation projects entail direct costs (e.g, engineering evaluations, the rehabilitation itself, temporary relocation), and these have to be allocated in some fashion or combination to building owners, tenants, government, and/or the public.

Second, seismic rehabilitation also entails social disruption (individual as well as neighborhood) and economic loss (foregone income). These "indirect costs," especially in urban areas, often affect the most marginal populations (the poor, minorities, the elderly) and must be borne in some way as well.

Third, it has proven inherently difficult to explain to affected populations the meaning of seismic performance levels, earthquake risk, and the effectiveness of — and trade-offs between — varying rehabilitation standards. While both direct and indirect costs are immediate, visible and have to borne by someone, the benefits of enhanced life safety are only probabilistic and rather vague (when an earthquake strikes, fewer lives will be lost); therefore, the debate often appears to suffer from misperception, misunderstanding, and shifting ground.

In fact, however, seismic rehabilitation involves values in conflict. The conflicts revolve around the trade-offs between improved life safety, a somewhat abstract concept, and very concrete costs, which are not abstract at all. Alesch and Petak (1986, pp. 66-67) capture the essence of this conflict with a quote drawn from one of the public hearings on the famous Los Angeles "Chapter 88" ordinance at which a citizen offered the following emotional observation:

> Now I've heard everything! Our brilliant City Council is going to tear down 14,000 buildings because there might be an earthquake that might knock these buildings down and the people might get hurt. So you're going to knock them down first and leave them [the people] homeless instead. That's like cutting off your arm so then you won't ever have to worry about breaking it. Are you gentlemen playing with all your marbles?

Fourth, earthquake awareness varies significantly across regions of the United States and interacts subtly with all of the above, with a normalcy bias (don't rock the boat), and with a reluctance by political leaders to being perceived as "unfair." The perception of being unfair needs explanation, however. Even if their life-safety motives are as pure as driven snow, political leaders are sensitive to this charge for it has deep roots.

The nation's founding fathers included in the *Bill of Rights* a guarantee against *ex post facto* (retroactive) legislation–that is, they expressly forbade laws that would make illegal an act that was not illegal at the time it was committed. This is a prohibition against "changing the rules after the game has been played." In the earthquake safety domain, seismic rehabilitation tends to strike this "changing the rules" nerve in our culture. It actually took a 1966 California Supreme Court decision to clear away legal obstacles for jurisdictions to require the abatement of a hazardous structure. While the particular case *(City of Bakersfield v. Milton Miller*) involved condemnation based on fire hazard, the decision provided the legal basis for subsequent retroactive earthquake programs in California. The court held:

> The fact that a building was constructed in accordance with all existing statutes does not immunize it from subsequent abatement as a public nuisance. . . . In this action the City [Bakersfield] does not seek to impose punitive sanctions for the methods of construction used in 1929, but to eliminate a presently existing danger to the public. It would be an unreasonable limitation on the powers of the City to require that this danger be tolerated ad infinitum merely because the hotel did not violate the statute in effect when it was constructed 36 years ago.

The essential validity of *City of Bakersfield v. Milton Miller* was upheld in 1984 by *Barenfeld v. City of Los Angeles*, a case specifically involving earthquake-vulnerable buildings. Thus, for improved seismic safety, it seems that "changing the rules" is an inevitable byproduct of disaster learning and the impact of such learning on governmental responsibility for public safety.

Historically, earthquake disasters often have provided nasty surprises by showing entire classes of buildings to be seismically unsafe. The 1933 Long Beach earthquake demonstrated unreinforced masonry (URM) bearing wall buildings to be unsafe and the 1971 San Fernando earthquake confirmed the poor performance of these buildings and also showed that more newer "soft-stories" and "tilt-ups" were unsafe. The problem, of course, is that these types of buildings were not known to be earthquake-vulnerable or to pose life safety threats when they were originally constructed. Indeed, many buildings now deemed unsafe in an earthquake of a specified magnitude and ground motion met code requirements or at least common practice at the time of their construction. This "then/now" knowledge problem is the source of the tension between disaster learning and the political-cultural reluctance by decision-makers to be seen as changing the rules retroactively.

The most recent example of an unpleasant earthquake lesson comes from the 1994 Northridge earthquake, which revealed as vulnerable steel frame buildings, long believed to be the most earthquake-resistant type of construction. As a January 20, 1995, press release from the Structural Engineers Association of California, Applied Technology Council, and the California Universities for Research in Earthquake Engineering (SEAOC/ATC/CUREe) noted:

> The damage to . . . steel buildings has raised many serious questions for the design profession. Because many damaged structures were designed using the latest building codes and built according to modern construction practices, seismic building codes for steel construction have been essentially invalidated.

In sum, earthquakes teach, usually painfully if not tragically, but the learning generates state-of-the-art advances in earthquake engineering that, in turn, generate "guilty knowledge" about flaws in the existing building stock. The term "guilty knowledge" refers to the gap in time between the lessons disasters teach to the design professions and the corresponding policy and administrative changes. This time lag between awareness of specific risks and appropriate mitigation actions — the gap between a spot on the engineering and geotechnical learning curve and a spot on a corresponding public policy and administrative curve — has been termed "guilty knowledge." This term is a convenient way to express two different learning curves; it does not have any legal implications as used in this context (Olson and Olson, 1996, p. 30).

The increasingly sophisticated knowledge within the engineering community about weaknesses in the seismic resistance of various types of existing buildings is the moral and professional core of, and the motivator for, the *Guidelines* documents. If the engineering state of the art were static and no learning occurred, there would be no "guilty knowledge" and no need for seismic rehabilitation or, for that matter, the *Guidelines* documents and this volume. To the contrary, however, the engineering state of the art is dynamic, not static; disaster learning occurs, generating guilty knowledge: Thus, seismic rehabilitation becomes professionally important, and the *Guidelines* documents, and this volume are now necessary.

RAISING EARTHQUAKE AWARENESS

In recent years, considerable effort has been devoted to the preparation and wide dissemination by the Building Seismic Safety Council (BSSC) of provisions and technical criteria for the construction of new buildings and certain nonbuilding structures. Of particular relevance to the rehabilitation-focused *Guidelines* documents, however, was a finding from an evaluation of the dissemination process of the BSSC's new buildings resource document:

> Much of the success of BSSC's program was contingent upon first raising the target audiences' awareness of the nature of local seismic risks and of the *NEHRP Recommended Provisions* themselves. [Regarding implementation] the planning should take into account the importance of coordinating this effort with educational programs being conducted by other federal, state, regional, and local governmental agencies as well as non-profit professional and trade organizations (Nigg and Mushkatel).

Awareness was and remains the key to managing everything in the nontechnical aspects of seismic rehabilitation but especially to the approach and tactics chosen. Except for relying on normal attrition, many decisions will boil down to managing levels of anticipated conflict inherent in choosing seismic rehabilitation strategies.

ATTRITION: THE PERMANENT CONTEXT

It must be kept in mind that a regular building replacement process is ongoing in virtually every jurisdiction in the United States, a process that directly affects the earthquake-vulnerable building problem. For seismic rehabilitation, this attrition is a contextual process of building replacement that can — but not always does — make the hazardous structure problem more tractable. For attrition to have a positive effect on seismic rehabilitation, a jurisdiction must exhibit strict adherence to current codes containing seismic provisions appropriate for its seismic risk zone. The idea is to prevent the construction of new buildings of the types previously identified as earthquake-vulnerable (and of other earthquake-vulnerable classes for that matter) while the normal process of building replacement slowly reduces the number of existing earthquake-vulnerable buildings.

It might be helpful to think of earthquake-vulnerable buildings as a "stock and flow" problem. At any point in time, a jurisdiction will have a certain number of buildings that present life-safety threats in an earthquake of a specified magnitude and ground motion. That is the "stock" of the problem. Simultaneously, normal attrition processes in the community are reducing the number of vulnerable buildings, which is the "flow out" as it were. One key mitigation measure then is to prevent new, nonearthquake-resistant buildings from being constructed, which is the "flow in." In fact, in jurisdictions where an earthquake risk exists but the building codes do not have adequate seismic requirements or where the seismic requirements are not adequately enforced, the stock of vulnerable buildings may actually increase (i.e., if "flow in" exceeds "flow out," the stock of problem buildings goes up). Thus, for attrition to work positively with, not negatively against, efforts at seismic rehabilitation, a jurisdiction must keep up with the state of the art in building codes, enact them in a timely manner, and see to their careful enforcement.

Looked at from a different perspective, attrition is a race between building replacement and the recurrence interval of the appropriate "planning earthquake" for that jurisdiction. The assumption is that attrition will reduce the number of earthquake-vulnerable buildings to some acceptable minimum before the next earthquake capable of bringing them down or rendering them economically useless occurs.

For the record, assuring that attrition plays a positive role in abating the hazard posed by earthquake-vulnerable buildings is not without a level of conflict itself. Enactment and enforcement of a building code for new construction always entails debate, especially for jurisdictions that have never had a building code or seismic provisions within that code. Such conflict is usually limited to scientific and technical arguments about the existence of an earthquake hazard in that jurisdiction or, if existence of hazard is accepted, the severity of the risk. In the latter case, arguments about recurrence intervals for a specific magnitude event (the planning earthquake) predominate.

Extended attention to attrition is given here precisely because it is permanent and will play a role in every one of the three following models of seismic rehabilitation, even in the "Mandatory Program Model." For example, in the Los Angeles program, attrition alone over the life of the program was expected to reduce the number of unreinforced masonry buildings (URMs) by 50 percent (4,000 buildings), leaving the city with only a hard core of 4,000 URMs with which to deal. As of 1991, 10 years after enacting the URM ordinance, of the URMs in Los Angeles, 53 percent had been strengthened, 17 percent had been vacated or abandoned, 16 percent had been demolished, and 14 percent were still pending action (by 1995, this may have been reduced to 5 percent according to Comerio, 1991, and personal communication, 1995).

MODELS OF ESCALATING CONFLICT

Two observations can be offered about the conflict potential inherent in the application of the *Guidelines* documents. First, the higher the earthquake awareness or "earthquake consciousness" of a region or jurisdiction, the easier it will be for proponents to explain enhanced life-safety probabilities and thereby justify and gain acceptance of seismic rehabilitation, at least as a concept. Looking back, it is not a coincidence that California has been a legislative leader in hazardous structure abatement at both the state and local levels with the most famous ordinance being "Chapter 88" of the *City of Los Angeles Building Code*.

Second, most analyses have focused on formal hazardous structure abatement programs that involve public policy directed at rehabilitating an identified set of structures. Indeed, the only book-length study is Alesch and Petak's 1986 *The Politics and Economics of Earthquake Hazard Mitigation: Unreinforced Masonry Buildings in Southern California*, which describes and analyzes the abatement efforts in (chronologically) Long Beach, Los Angeles, and Santa Ana.

In such formal or "mandatory" programs, the criteria, priorities, timetables, and costs are publicly debated — always contentiously — before the decision-makers (usually a city council) reach the final approval stage and then move into implementation. Little wonder that local governments find mandatory programs very difficult to enact and implement.

Such programs must be technically defensible, must provide for exceptions and appeals, require staff or consulting expertise, and must be perceived as not violating the "not changing the rules of the game" principle of fairness or as singling out owners and occupants of the targeted building class(es) for costly rehabilitation measures. As a result, mandatory programs tend to mobilize vocal constituencies. California examples of this type of formal program would include not only Los Angeles, Long Beach, and Santa Ana but also Santa Rosa and a few other cities.

The mandatory program idea, however, is not feasible for most jurisdictions in the United States outside California given the varying levels of seismic hazard but low levels of seismic awareness. Only in jurisdictions with relatively high levels of seismic hazard and awareness will a mandatory program proposal achieve a place on political agendas, in part because it effectively lodges at the upper end of a policy escalation ladder based on conflict potential.

There are, however, two other generic seismic rehabilitation policy options, both of which may be more realistic for much of the United States than the "Mandatory Program" model: the "Informal/Encouragement Program" model and the "Voluntary Program" model. To illustrate the level of conflict associated with the three models, see Figure 1 below which places them on a 10-point "escalation ladder."

Note, however, that this escalation ladder should not be confused with seismic rehabilitation triggers, which are discussed later and define under what conditions seismic rehabilitation requirements must be met. Rather, this ladder is a way of viewing the range of possible policy choices and sorting out their respective implications.

The escalation ladder also highlights another crucial variable — the degree of "pro-activity" exhibited by a building department. As will be explained below, in the "Voluntary Program," a building department is essentially passive. In the "Informal/Encouragement Program," a building department plays a stronger, more pro-active role, although on a selective basis. In the "Mandatory Program," however, a building department is on the point, pushing or at least implementing surveys and program directives.

10 (Highest Conflict)
9 The "Mandatory Program"
8
7
6 The "Informal/Encouragement Program"
5
4
3
2
1 (Lowest Conflict) The "Voluntary Program"

Figure 1 Seismic rehabilitation escalation ladder.

A slight variation of this approach reflects the com plexity of the relationships between levels of government. Sometimes local officials or, more precisely, local issue advocates want the rules to be set by the state, for example, because they expect a high degree of conflict over the issue. Even if they believe seismic rehabilitation is the "right thing to do," state mandates allow local implementors to skillfully avoid conflict by explaining that they have no choice but to "carry out a state mandate."

The Voluntary Program

Not adequately appreciated is the number of buildings that have been and are being seismically rehabilitated by their owners without compulsion by local building officials. Such rehabilitation may focus on the seismic aspect alone or may feature seismic aspects as part of a larger remodeling effort. Either way, it is essentially a private or at least an owner-driven and, therefore, low-conflict process that explains its placement at conflict point "1" on the escalation ladder. Under this "Voluntary Program," owners decide, for a variety of reasons, to seismically rehabilitate their structures and approach building officials for permits and perhaps even for assistance or advice on how a building or buildings might be modified to achieve a desired level of earthquake performance. The building official then permits owners to rehabilitate the buildings on their own. Interestingly, following damaging earthquakes, voluntary rehabilitations often surge — even in jurisdictions not directly affected by the event.

The advantages of the "Voluntary Program" are considerable. Government coercion is not needed. Ordinances are not required. The media do not become involved. Motivations and decisions are largely internal. Courts and lawyers are largely avoided. Politics is seldom a factor. Community impacts are relatively minor. This approach is neither as rare nor as utopian as it might appear. Seismic rehabilitation is going on all the time in a wide variety of jurisdictions, but it occurs largely without notice except possibly within the local professional community.

Chosen from literally dozens of examples, four significant voluntary rehabilitations are described below: a public building in Utah; a private building in South Carolina; a private multibuilding complex in California; and a school rehabilitation program in Missouri, the case that best illustrates the model. Each case is different, but all share the common theme of low profile, internal decision-making and self-funding. A fifth case from Tennessee, an effort that was unsuccessful, is also described below for the sake of balance.

Voluntary seismic rehabilitation appears to occur in either of two contexts. In some cases, seismic considerations are piggybacked onto broader remodeling or rehabilitation efforts. In other cases, the seismic rehabilitation is an end in itself and is undertaken as an investment in the survival of the building against a recognized earthquake threat. The essence of the decision remains at the building level, and it is made by the owner, although mortgage and/or insurance companies also may play a role.

A special note on remodeling is in order. A remodeling effort can cut both ways for seismic resistance of a structure. While seismic strengthening obviously can be piggybacked onto remodeling, a danger lurks there as well. Unless a building official is attentive, especially in areas where earthquake awareness is low, remodeling can actually reduce the earthquake resistance of a structure depending upon how the remodeling is designed and carried out (e.g., it can weaken a load bearing or shear wall). One building official who caught such a remodeling weakening combination termed it a version of "one step forward, two steps back." The *Guidelines* documents themselves serve as a bulwark against such inadvertent weakening and as a resource for building officials caught in such situations.

The "Voluntary Model" contains obvious defects. First, the scope is limited only to those buildings whose owners are enlightened and/or who see long-term financial advantages in seismic rehabilitation. In other words, the rehabilitation is not systematic and depends upon financial feasibility and owner receptivity or "good citizenship." Second, the pace of seismic rehabilitation in a community is unpredictable for the same reasons. Third, the direct costs as well as the indirect costs will be passed along to the tenants, employees, and/or consumers without public discussion and, therefore, without a wide airing of alternatives and consideration of amelioration possibilities for those affected. Fourth, it is likely that the "worst" buildings, precisely because they are marginal-value properties in the first place, will not be rehabilitated by their owners, a fact that has an interesting dark side.

If we assume that seismically rehabilitated commercial and residential buildings will command higher rents, it will drive out the poorer tenants and send them toward cheaper space — very likely into those buildings whose owners have not seen fit to rehabilitate their structures. Therefore, at least in the short to middle run, it is possible that voluntary seismic rehabilitation may actually increase the population concentration at risk in other (unrehabilitated) buildings.

In addition, seismic rehabilitation and its costs are only inputs into a larger decision. While the *Guidelines* may offer seismic rehabilitation goals, techniques and cost estimates, other factors may prove decisive, especially if the total rehabilitation project costs outweigh new construction costs.

In total, the case studies illustrate that while the *Guidelines* documents will be extremely useful, many other factors often will be present. As appealing as voluntary approaches are, there are some serious risk perception and economic obstacles to their more widespread use. Among them are individuals' estimation of the probability of an earthquake damaging their structure being sufficiently low that the investment in rehabilitation will not be justified; the tendency to assign very high discount rates to such decisions, which results in giving future benefits very little weight compared to spending money for protective measures; and judgments that current prices for seismic rehabilitation measures simply are too high, to even focus on the potential value of reducing future losses. Such determinations are likely based on arguments having little to do with expected benefit/cost comparisons.

Case 1: The 1894 Salt Lake City/County Administration Building

Salt Lake City, like all major population centers in Utah, sits astride the Wasatch Fault at the base of the Wasatch Mountains. The fault is considered historically active but so far has not done major damage to the urban areas of Provo, Salt Lake City, or Ogden. The U.S. Geological Survey and the Utah Geological Survey consider the earthquake threat to be serious.

In the late 1980s, Salt Lake City faced the problem of what to do about its earthquake-vulnerable but historically and architecturally valuable Administration Building. The decision was made to seismically rehabilitate it using a "base isolation" method. The rehabilitation was undertaken voluntarily and paid for by the city to protect a major asset and to serve as an example of government leadership and responsibility in seismic safety.

Case 2: The North Charleston Hotel

A major hotel chain faced an interesting problem after constructing a new hotel in the city of North Charleston, South Carolina. At the time of construction, North Charleston had no specific earthquake-resistance requirements in its building code, in large measure because the state did not have (and as of May 1996 still did not have) a building code.

After construction of the hotel, however, a national insurance company would not accept the mortgage because it had evaluated regional seismic risk (hardly a secret given the 1886 event) and noted the lack of an appropriate seismic component in the original design of the building. The insurance company then commissioned a San Francisco engineering firm to recommend a rehabilitation plan that would meet the company's earthquake performance requirements for the region. Subsequently, an external steel frame that tied back into the original concrete frame was added to the hotel. In short, the investment — or more precisely, the collateral — was protected.

All of the key decisions were made in the private sector. This case provides an important perspective on how the insurance industry, banks, and other financial institutions and the building and real estate communities could work together to foster seismic rehabilitation with or without governmental participation.

Case 3: The PG&E Buildings, San Francisco

The Pacific Gas and Electric Company (PG&E) is headquartered in San Francisco and has a long and colorful history in "The City." At an approximate total cost of $150 million, PG&E chose to seismically rehabilitate a complex of four of its older office buildings partly using the benefits of the Preservation Tax Incentives for Historic Buildings. The rehabilitation was reviewed by the California State Office of Historic Preservation and the National Park Service and certified as meeting the Secretary of the Interior's Standards for Rehabilitation, thus earning a 20 percent investment tax credit (approximately $30 million).

The motives were four: to remain in the city, to save landmark structures facing the famous Market Street, to protect PG&E employees, and to set an example in the community of a voluntary business commitment to earthquake safety in general and to seismic rehabilitation specifically. The details of this case are especially interesting. According to representatives of PG&E's structural engineering consultants (Jokerst and Elsesser, EERI, 1995):

> *The complex of four pacific Gas and Electric Co. Office Buildings in downtown San Francisco built from 1921 to 1949 represent a variety of multi-story construction ranging from 9 stories to 18 stories and encompass over 500,000 square feet of floor area. These buildings are part of an essential complex for the public utility which provides natural gas and electricity to Northern California.*
> *After the 1989 Loma Prieta earthquake, which caused limited damage to the buildings, PG&E determined that a seismic upgrade of these four old*

steel frame buildings was justified to meet the corporate goal of being operational after a strong earthquake.

Ten seismic strengthening options were studied for the two primary 18-story L-shaped buildings forming the center of the complex. Each alternate was evaluated to determine its impact on (1) interior space planning, (2) historic features, (3) dynamic response, (4) capacity of existing foundation, (5) existing frame capacity to support the increased seismic loads, (6) pounding between the adjacent structures, and (7) lateral drifts.

The PG&E complex demonstrates a performance-based approach to design which goes beyond the simple code-based life safety methods. This project addresses the desire by Pacific Gas and Electric Company for a facility which will serve the public after the next damaging earthquake.

Case 4: A Missouri School District

A special version of the "Voluntary Program" is exemplified by officials of the School District of Clayton, Missouri. Part of the greater St. Louis area, the District needed a voter-approved $6.6 million bond issue to finance new or replacement construction and a range of school improvements. These officials recognized the earthquake threat in the New Madrid area but understood equally well that the public threat perception was low. By "packaging" seismic considerations as one of the five "compelling and immediate needs" inside an overall bond argument, however, the Clayton School District won the bond election and was able to carry out nearly $3 million of seismic rehabilitation projects "by strengthening portions of existing schools."

Case 5: Memphis, Tennessee

The first four cases and the description of the Voluntary Model tend to bias perception in that only "success" stories are told. As a partial balance to this somewhat excessive optimism, consider the story of a major automobile parts and accessories chain with headquarters in Memphis that evaluated its present location in a structure designed originally as a department store. Seismic performance was explicitly included in the overall rehabilitation evaluation; however, in the end, the company chose to construct a new building with appropriate seismic design in the downtown area because all things considered, constructing a new building was actually less costly than rehabilitating the old one. If, as in this case, the total project cost outweighs that of constructing a new building, seismic rehabilitation most likely will not be occur.

The Informal/Encouragement Program

Like the voluntary approach, the "Informal/Encouragement Program" is more common than is often appreciated. Although not commonly acknowledged, building officials often try to reach agreement with owners involved in building rehabilitation. Such negotiations can be based on authority granted by local ordinance or can be conducted as part of a building official's administrative responsibilities. This is because each building "has its own story."

A former midwestern city building official commented that "in contrast to new construction, negotiation is a way of life in dealing with existing buildings, and the architect/engineer/owner could walk away from negotiation or use a board of appeals process." This approach involves a building official negotiating seismic considerations into an owner's request for permits to remodel an existing structure. In this case, an owner requests permits to do various kinds of work on a structure, and a local building official says in effect, "Okay, but you also have to include some seismic rehabilitation measures as well." Four example cases are presented below.

Case 6: Provo, Utah

The city of Provo, which like all other cities in Utah sits along the Wasatch Fault, achieves seismic rehabilitation of existing buildings by negotiation with building owners. No mandatory requirements exist to require the seismic rehabilitation of URM buildings. The building department applies its negotiated informal approach only when a significant improvement or change occurs to one of these buildings, most of which are located in the older central business district and date from the late 1800s.

The standard for URM building strengthening in such cases is the current Uniform Code of Building Conservation (UCBC), Appendix Chapter 1. Example alterations that affect structural elements or increase loads include adding to a mezzanine or changing uses that would increase floor live loads. When an agreement is reached between the building official and the owner on the scope of the seismic rehabilitation effort, the official issues the permit.

In recent years, however, none of the subject buildings has had any alterations proposed that would trigger discussions about seismic rehabilitation. It is possible that once an owner becomes aware that the city might require seismic strengthening, the scope of the proposed project is changed to avoid such work or, in some cases, the project is canceled. In some cases, it may be that the requirements for seismic rehabilitation, albeit negotiated informally, are sufficient to deter some significant property improvements in the area.

It is interesting to note that in 1995 Provo's building department proposed a mandatory parapet bracing requirement. Principally because of cost concerns, the proposal never got far enough along in the policy process to reach the city council. Interestingly, the council has rather deftly stayed on the sidelines in discussions related to building codes. It generally defines code issues as "technical" rather than more broadly political, thus containing the debates within a relatively narrow circle of building officials and other stakeholders and interested individuals.

Nevertheless, some progress is occurring. In addition to URM buildings, when improvements or additions are made to wood frame buildings, the city looks for evidence that the wall sill plates are anchored to the foundation or slab. If these connections do not exist or are less than the code required minimum, the city requires new anchors (sill bolts) to be installed as a condition of the permit.

Case 7: Seattle, Washington

When a building undergoes substantial remodeling in Seattle, seismic rehabilitation is mandated. The extent of the improvement in its seismic performance can be negotiated, however, under the following 1995 revision to the Seattle Building Code:

> ***3403.3 Impracticality.** In cases where total compliance with all the requirements of this code is impractical, the applicant may arrange a pre-design conference with the design team and the building official. The applicant shall identify design solutions and modifications that conform to Section 104.14. The building official may waive specific requirements in this code which he/she has determined to be impractical.*

Section 104.14 states that an "alternate" may be approved by the building official if he/she finds that it "complies with the provisions of this code and that the alternative, when considered with other safety features of the building or other relevant circumstances, will provide at least an equivalent level of strength, effectiveness, fire resistance, durability, safety and sanitation."

Case 8: Palo Alto, California

Home to Stanford University and many high technology companies, the 55,000-person city of Palo Alto recognized its earthquake-vulnerable buildings problem and has taken a unique approach to seismically rehabilitating these buildings. After a lengthy exploration and negotiation process, the city adopted a "Seismic Hazard Identification Program." It does not fall neatly into any program category, but mostly resembles the "Informal/Encouragement Program" because some of the program's elements are mandatory while others are voluntary and incentive oriented.

Palo Alto's efforts to deal with its vulnerable buildings date from the mid-1970s, but it was the 1983 Coalinga earthquake that led to the creation of a Seismic Hazard Committee "representing a diversity of interests" (stakeholders), which ultimately agreed upon the scope of the existing program. The key elements of Palo Alto's program are:

- *It imposes rehabilitation requirements on 99 structures in three categories (all URM buildings, all pre-1935 non-URM buildings with 100 or more occupants, and all buildings with 300 or more occupants constructed between January 1, 1935, and August 1976).*
- *Once notified by the city, the buildings' owners are required to contract with a structural engineer. Given a specified time period in which to*

conduct a study and file a report with the city, the owners' engineers have to evaluate the earthquake vulnerability of the building and to identify what should be done structurally so that the building will meet the seismic provisions of the 1973 Uniform Building Code (UBC). The reports are reviewed by consulting engineers to ensure they comply with the ordinance.

- *Each building owner must notify the occupants in writing that an engineering report has been completed and that the report is available for review in the city's Building Inspection Division.*
- *Within one year after filing the engineering report, each building owner also must submit a letter indicating his/her intentions regarding correction of seismic deficiencies. Failure to comply could result in injunctive relief, criminal prosecution, or both.*

The underlying policy philosophy was that "while no mandatory retrofitting (rehabilitation) requirement was imposed . . . the reporting requirements would create sufficient concerns about liability and about the decline in the market value of earthquake-deficient structures, that seismic improvements would occur voluntarily" (Beatley Berke, pp. 63-64).

Some clues are available about the implementation of the program:

- *A downtown density and parking incentive are provided for seismically rehabilitated buildings. Bonuses are given for the buildings in the three categories that exempt them from providing on-site parking as a condition of rehabilitation.*
- *Compliance with the reporting requirements has been good — virtually 100 percent.*
- *The reports and public disclosure requirements — reinforced by California's real estate disclosure laws on property sales and purchases — act as strong incentives and a number of seismic upgrades have been completed.*
- *Some tenants in leased buildings have helped finance the seismic upgrades through lump-sum payments or higher lease costs, and others have agreed to vacate before and return to the building after the seismic rehabilitation project is completed. This protects the owners' abilities to service their debts.*
- *Some innovative developers have found ways to capitalize on the seismic rehabilitation program by publicizing the work done, taking advantage of the greater square foot allowances provided under the parking incentive measure, and even trying to obtain the bonus for buildings not in the three covered categories.*
- *Early fears that owners would be unable to continue to insure their governed properties for liability are not being borne out. Increases in rates, however, are a possibility.*
- *The private owners are carrying the direct costs of the program's reports and seismic rehabilitation improvements.*

An interesting sidebar to Palo Alto's program that may have reinforced private owners' willingness to accept the ordinance was that the city voluntarily seismically rehabilitated its Civic Center building. This structure was constructed between 1968 and 1970 and is an eight-story tower supported by a three-story below-grade parking structure. The project was financed by "Certificates of Participation," and the work was done in slightly more than two years "while the building was occupied and in full operation" (Sharpe p. 1).

Case 9: San Leandro, California

The 15 square mile Alameda County city of San Leandro borders Oakland on the north and is a mixed residential, commercial, and industrial area of about 70,000 mostly middle-income residents. The eastern part of San Leandro spans the active Hayward Fault. San Leandro has dozens of URM buildings, thousands of older wood-frame dwellings, modern apartment structures, and tilt-up light industrial buildings along the San Francisco Bay's shoreline, all of which are earthquake-vulnerable.

The city's earthquake safety efforts — triggered by the recommendations of a citizen task force — demonstrate an interesting voluntary government-citizen partnership. Known as the "1993 Seismic Retrofit Financing Project," the city council approved raising $12,780,000 through "Certificates of Participa-

tion" to seismically strengthen several municipal buildings. The buildings included rehabilitating the 1965 City Hall, the 1970 South Office Building, and the 1968 Public Safety Building, which houses San Leandro's fire and police departments and their communications and dispatching centers.

In addition, the city has supported seismic rehabilitation by its residents. Part of an annual $300,000 earthquake preparedness appropriation (which includes federal mitigation grant funds) assists residents with the strengthening of their homes. Detailed easy-to-understand instructions are provided to owners by the building department; classes are provided by qualified engineers; tools are loaned to property owners; the work is inspected at no charge; and the property owner receives certification that the building has been strengthened to the city's standards.

In general, the "Informal/Encouragement Program" would have to be marked as medium-conflict ("5" or "6" on the escalation ladder) because, no matter how informally the seismic requirements are leveraged in, it is a form of government mandate to have seismic rehabilitation included as a "must be" part of an overall permit process. Under this model, a building department is obviously proactive, not passive, but in a selective manner.

In practice, when a jurisdiction employs this approach, building owners tend to complain that the city building department is being "unreasonable." While probably rare, attempts at political end-runs to a city council, mayor, or city manager could be made to test the resolve of the building department — and its political support. Seattle's experience is that almost no appeals have gone to its mayor or council. This is because its seismic rehabilitation triggers (when is rehabilitation required) are specified in ordinances even though the extent of the rehabilitation work involved is negotiated. In general, it is both clear and prudent that building departments have some reference standard, such as the UCBC or formally adopted ordinances, to avoid the potential nightmare of inconsistent and capricious requirements being imposed. At the same time, however, formal rehabilitation ordinances are not required, neither the media nor the courts tend to be involved, and the political conflict generated remains contained within a fairly small circle of officials, owners, and engineers. In other words, seismic rehabilitation does not become an explosive public issue, which is often the case with the upper end inhabitant of the escalation ladder, the "Mandatory Program Model." Finally, owners may abandon their projects or redefine them to avoid triggering even informal requirements. A common way of doing this is to perform a series of smaller projects that do not trigger seismic rehabilitation but that collectively result in a major alteration.

The Mandatory Program

As indicated above, the "Mandatory Program" is definitely high-conflict and rates a kind of general "9" on the ladder, but it could range anywhere from "8" to "10." For example, if the number of buildings targeted in a jurisdiction is relatively small and if the required rehabilitation is at least partially subsidized (e.g., through a redevelopment project), the score could be an "8." On the other hand, if, as in the famous Los Angeles case, thousands of buildings are involved and no external financing is offered, the program can — and did — reach a "10" on the conflict ladder. In essence, mandatory seismic rehabilitation programs are full blown public policy. As such, formal ordinances stipulate priorities, criteria, processes, choices, rules, coercive measures, timetables, and even appeal processes. Moreover, given the very public nature of the decision-making, the process is long, arduous, and very political.

Not only does a "Mandatory Program" debate entail extended technical arguments, it also gives at least equal time to the direct cost question (how much for what level of safety), the cost incidence question (who pays initially but who pays in the end), and the indirect cost considerations (differential impacts on marginal populations, personal disruption, neighborhood effects). Battles also are joined on scope (what buildings), priorities (which buildings first and why), and pace (how fast). Most important, a mandatory program stimulates the creation of what once were called "interest groups" but now are more accurately referred to as "advocacy coalitions" or "stakeholders," each having its agenda or special focus. As a result, the media and the courts become involved, often sooner rather than later.

In the "Mandatory Program," seismic rehabilitation is imposed coercively on building owners by government, and most of the politics revolves around attempts by the owners to minimize the scope and requirements of seismic rehabilitation and, therefore, the costs. Owners then attempt to externalize (shift to others) those costs to the greatest degree possible. The decision arena is usually a city council, and mandatory programs tend to involve not only the elected officials but also numerous individuals and groups including building owners, tenants, building safety officials, professional engineers, historic building advocates, neighborhood organizations, and even representatives of other levels of government. The "pro" and "con" sides (advocacy coalitions) become very complex. In a discussion separate from his book with Alesch, Petak offers a summary of the kinds of actors involved in the development and passage of the hazardous structure abatement ordinances in Long Beach, Los Angeles, and Santa Ana (see Figure 2).

In addition to its own intrinsic conflicts, any proposal for a formal seismic rehabilitation program must face "extrinsic" challenges. That is, aside from all the internal debates, seismic rehabilitation using the mandatory approach must compete with other community priorities for scarce public funds, even if only for enforcement costs. These costs should not be underestimated in that they often entail new responsibilities for a building and safety department and very likely for the city attorney's office and planning and housing departments in larger cities.

Case 10: Long Beach — It Led The Way

As a result of the major earthquake of 1933 which bears its name, the city of Long Beach amended its building code in January 1934 to effectively prohibit any future construction of unreinforced masonry buildings, hundreds of which suffered serious damage in the earthquake. This policy was extended statewide by the Riley Act, which was passed in 1934 by California's Legislature.

Nothing was done about existing URM buildings in Long Beach until 1959 when a true hero of local efforts at seismic safety, building official Ed O'Connor, took advantage of a theater relicensing controversy to push through an ordinance giving the building department the authority to "determine by inspection if an existing building is substandard or constitutes a nuisance" and, if so, to order the building repaired, vacated, or demolished. Once a 1966 California Supreme Court decision (City of Bakersfield v. Milton Miller) cleared the way by determining that it was unreasonable to hold cities hostage to old buildings given "the fact that a building was constructed in accordance with existing statutes [at the time of its construction] does not immunize it from subsequent abatement as a public nuisance," O'Connor attempted to implement the original Long Beach ordinance. A political uproar ensued, and while the URM problem was "studied" at length, effective implementation of the ordinance was tabled, but it at least had gone through the formal hearings process.

Major damage to URMs in the 1971 San Fernando earthquake rekindled Long Beach's interest in its URM problem and on June 29, 1971, the Long Beach City Council passed a specific ordinance to abate the hazard posed by earthquake-vulnerable structures in the city. Implementation was slowed by complexities in the ordinance such as the assignment of "hazard points," which was confusing to the owners. O'Connor argued that it was very difficult to enforce an ordinance with multiple choices. In 1976, an amendment established a more formal but simpler program with criteria for a building-by-building "hazard index" and with timetables for surveys, notifications, evaluations, and abatement. Eventually, almost 900 pre-1934 masonry, concrete, or steel buildings were either seismically rehabilitated or demolished. Thus, while Los Angeles may be more famous, its neighbor, the City of Long Beach, led the way.

Case 11: Los Angeles — The Most Famous

Although "guilty knowledge" about the earthquake vulnerability of URM buildings had existed for several decades (at least since the 1933 Long Beach event) and although the city of Long Beach itself had been working on the earthquake-vulnerable building problem since 1959, it took the devastatingly concentrated life loss of the 1971 San Fernando event (47 of the 54 fatalities took place in portions of the

DECISION MAKERS

Mayor and City Council Members
State Governor & Legislature
State Seismic Safety Commission
State Office of Emergency Services
State and Federal Supreme Courts
Federal Funding Agents

PROPERTY OWNERS & TENANTS OF UNREINFORCED MASONRY BUILDINGS

Residential Homeowners & Tenants
Absentee Owners of Dwellings or Business Units
Small Businessmen who Own or Rent
Large Business Owners who Own or Operate Businesses/Corporations

SEISMIC RISK

FROM

UNREINFORCED MASONRY

STRUCTURES

THIRD PARTIES

City Building and Safety Departments
City Planning Departments
City Attorney
Professional Engineers & Architects
University Researchers
Professional Consultants
Banks and Real Estate Firms
Politicians who Represent the Citizens in the Risk Areas
The Citizenry - at - Large

Apartment Owner Associations
Theater Owner Associations
Community Interest Groups
Residents/Owners Adjacent to Hazardous Buildings
Service Workers in Buildings
Historical & Conservation Associations
Tax Officials
Friends & Relatives of the Property Owners/Tenants

Figure 2 A sampling of parties concerned with city seismic regulation development (from W. J. Petak).

FIGURE 3
Advantages and Disadvantages of Major Types of Mitigation Programs for Unreinforced Masonry Buildings

Program Description	*Advantages*	*Disadvantages*
	Mandatory Strengthening Programs	
• Requires owners to reduce earthquake hazards within established time frames • Timeframes for compliance start when an order is issued by the Building Department • Establishes seismic retrofit technical standards • Sets a goal of hazard reduction, not total elimination of the hazards	• Local governments can effectively enforce the program and reduce hazards • Building departments can monitor and report progress • Building departments can control compliance rates by slowing down or speeding up the issuance of orders to building owners • Compliance rates vary with the number of building occupants, with longer time frames for smaller buildings	• Imposes arbitrary and at times inflexible deadlines on building owners • Compliance schedules do not necessarily reflect the limits of the local design and construction industry resources • Can impose economic hardships on owners and occupants • Compliance schedules do not consider hazards to passersby or hazards from adjacent or unoccupied buildings.
	Voluntary Strengthening Programs	
• Requires owners to prepare hazard evaluation reports • Requires owners to write letters that indicate their intentions to reduce hazards • Reports and letters are made available to the public • Establishes seismic retrofit technical standards • Owners set their own time frames for compliance with standards	• Provides effective disclosure of hazards to owners and in some cases to tenants • Flexible time frames for compliance can result in fewer economic difficulties • Rates of hazard reduction can vary depending on owner's resources and demands on the design and construction industry • Provides an effective management and monitoring system to local governments • Local governments can always reconsider the program's progress and impose mandatory requirements if it is ineffective.	• Effective in reducing hazards only if coupled with strong economic environments, and financial, planning, and zoning incentives • Not effective with owners who choose not to cooperate, and thus can be unfair to cooperative owners • May prolong overall hazard reduction efforts and earthquake risk exposure • Owners must pay higher fees to design professionals • Does not consider hazards for occupants and passersby or from adjacent buildings
	Notification-Only Programs	
• Owners are notified by letter that their buildings are potentially hazardous	• Some local governments state that it meets the minimum intent of the URM Law • Minimal initial cost to local governments • No direct cost to owners who choose to ignore hazards • Can be effective if owners are few and cooperative and if governments adopt seismic retrofit standards	• Programs have been ineffective in reducing earthquake hazards • Owners are not protected from future code changes if they choose to reduce hazards • Owners are not encouraged to consider hazard reduction • Owners are not informed of specific hazards and are likely to react with disbelief • Local government can't easily monitor hazard reduction progress • Imposes demands on local governments to deal with unhappy owners • Seismic retrofit standards are typically not adopted

Veterans Administration hospital built in 1925) to force open a political window of opportunity for seismic rehabilitation in Los Angeles in February 1973. The scale was daunting — the estimate was that the city had 14,000 earthquake-vulnerable buildings. A key actor once described the problem as: "How do you eat an elephant? Well, one bite at a time." Befitting the "Mandatory Program" model, debate over various versions of the hazardous structure abatement ordinance became very contentious very rapidly with building owners mounting strong attacks against each draft. Alesch and Petak (1986, p. 62) quote a leader of a group of apartment owners who captured almost all (he missed historic preservation) of the principal objections in a single diatribe:

> *The proposed ordinance is a direct attack on the poor . . . on senior citizens . . . on every tenant in the city . . . makes it impossible for the owners of and investors in the older buildings to comply with it . . . would put tremendous upward pressure on rents in the city . . . create unimaginable voter unrest . . . .*

After three years of conflict, the Los Angeles city Council sent a draft ordinance back to committee for further study in December 1976.

Advocates for an ordinance regrouped and found a city councilman (from the area most damaged by the 1971 San Fernando event) who took the public and political lead and guided the next version of the ordinance, which would become Division 88 of the Building and Safety Code, through a continuously acrimonious process to final passage on January 7, 1981. Almost eight years elapsed between placement of the earthquake-vulnerable buildings problem on the political agenda in Los Angeles and final passage of the ordinance.

Case 12: State of California Senate Bill 547 (and Senate Bill 445)

In June 1986, the Governor of California signed into law Senate Bill (SB) 547. This law require cities and counties in Seismic Zone 4 (which included approximately 80 percent of California's population) to inventory their URM buildings and, by January 1, 1990, to establish programs to mitigate the hazards they posed. For many jurisdictions, the results of the inventories were an unpleasant surprise and constituted the first solid information they had on the extent of their URM building problem. Because of SB 547, many jurisdictions suddenly had "guilty knowledge" about earthquake-vulnerable URM structures in their building stocks.

While SB 547 did not specify precisely what mitigation programs had to be put in place by the local jurisdictions, in 1991 the California Seismic Safety Commission (CSSC) identified the four types that had evolved: mandatory strengthening, voluntary strengthening, notification only, and "others." Not surprisingly, the CSSC preferred the mandatory approach, saw advantages in the voluntary program, but had serious reservations about the "notification only" program. The "others" were too varied to cover easily. The CSSC then outlined the advantages and disadvantages as they saw them of the three major types of URM mitigation programs (Figure 3).

Although enacted seven years earlier than SB 547, another law, SB 445, should be mentioned. SB 445 allowed local governments in California to adopt standards for seismic rehabilitation of URM buildings that were lower than the standards for new construction. SB 445 had a dual effect: It reduced estimates of the rehabilitation costs for URM buildings (because repair could be to a lower standard) but, more important, it removed local government concern about legal liability for having different standards for rehabilitation of existing buildings and new construction.

Case 13: Seattle—Changing Focus and Local Policy

The city of Seattle's experience illustrates how the failure of a mandatory retrofit ordinance led to the current negotiated methodology. In essence and for a variety of reasons, Seattle's policy moved from a focus on one area (the historic "Pioneer Square") to all business districts where parapets are common hazards and finally to a triggered mandatory requirement that applies to all existing buildings but that allows for negotiation of the level of structural improvement on a case-by-case basis.

"Pioneer Square" is a 15-square-block area adjacent to Seattle's central business district. Its buildings (largely URM) were constructed at the turn of the century. It provides an example of the difficult-to-implement mandatory rehabilitation policy for a specific district. In 1973, ordinances were passed that applied solely to the Pioneer Square Historic District. They specified minimum maintenance requirements and also required rehabilitation of the URM buildings (to ensure that all structural members could "carry imposed loads with safety" and prevent any portion of the exterior from falling in an earthquake). "Substandard historic building" notices were sent out, and by May 1977 only 18 out of 143 buildings had been partially rehabilitated buildings rehabilitation. Further achieving the necessary increased rents to pay for the improvements was often unrealistic. Lengthy hearings were required before the building department could take enforcement action and, as a result, the rehabilitation requirements were repealed and strengthening requirements were triggered only if a building was to be substantially remodeled.

In November 1975, a large section of terra cotta cornice tile fell from a multistory building onto a sidewalk near the downtown retail core. This event initiated a formal inspection and notification program for Seattle's central business district, in particular the entire downtown core. This was followed by adding new language to the 1977 Seattle Building Code that specifically required abatement of "unsafe building appendages" like URM parapets. An inspector/engineer was assigned to try to identify all such hazardous parapets (many of which were in Pioneer Square). Most of the hazardous parapets in the downtown area (including Pioneer Square) had their parapets braced. This ordinance is still used on URM buildings outside of the downtown area.

Thus, the mandatory requirement for the "global" (although "partial" in current engineering terms) rehabilitation of URM buildings failed, but a very modest mandatory requirement for strengthening one of the URM buildings' most widely recognized hazards (parapets) has been very successful.

A useful and successful example of seismic rehabilitation policies is Seattle's current one that applies to all existing buildings. When an existing building undergoes a "substantial remodel" (remodeling that extends its "useful physical and economic life"), its seismic risks must be mitigated. This trigger (and there are a couple of less frequent ones) is codified, not negotiated. There is usually a pre-design meeting with the owner, the engineer, and specialized building department staff. At this meeting, the level of structural improvements is negotiated, the goal being to ensure that the degree of improvement is "commensurate with the size and scope of the proposed project." Thus, the rehabilitation is mandatory (as triggered by a proposed remodel), but the level of structural improvement varies from case to case. This has been very successful for many years, and a wide variety of office, retail, light manufacturing, and residential (including low income) buildings have been rehabilitated.

Case 14: San Francisco's "Bolts-Plus" Partial Rehabilitation for Unreinforced Masonry Buildings

Passage of California's URM law in 1986 (Chapter 12.2, Section 8875 et. seq., "Building Earthquake Safety" of the Health and Safety Code) accelerated local government consideration of the URM problem. In San Francisco, this process ultimately resulted in the passage of San Francisco's Ordinance 225-92, on July 13, 1992, "relating to earthquake hazard reduction in unreinforced masonry bearing wall buildings." With the avowed primary social purpose of preserving low-cost housing, the ordinance has lower safety standards than the state-adopted model code (discussed below) when applied to normally configured residential occupancy buildings. Ordinance 225-92 allows residential and certain commercial use unreinforced masonry buildings (UMB in San Francisco terminology) to be rehabilitated using a "bolts-plus" solution ("the installation of shear and tension anchors at the roof and floors and, when required, the bracing of the UMB walls upon evaluation of the height-to-thickness ratio of these walls, Section 1603B1.1). This method cannot be used for buildings housing assembly, educational, or hazardous occupancies as defined in the building code.

The process of establishing the technical basis for Ordinance 225-92 is worth some discussion. As noted above, the state's URM law required local *governments in Seismic Hazard Zone 4 to identify (inventory) the quantity of URM buildings in their jurisdictions, to prepare a plan to mitigate the hazards, and to file a report on their actions with the California Seismic Safety Commission (CSSC). San Francisco identified 1,967 masonry bearing wall buildings. (Approximately another 120 nonbearing wall URM buildings also have been identified by San Francisco, but they are outside the scope of its retrofit ordinance.)*

In late 1988, San Francisco officials asked the Structural Engineers of Northern California (SEAoNC) to develop guidelines that could be used to prepare a city ordinance. SEAoNC appointed an ad hoc committee for this purpose. About the same time, the CSSC asked the counterpart statewide organization, the Structural Engineers Association of California (SEAoC), and the California Building Officials (CALBO) to help the Commission update its model ordinance focusing on bearing wall URM buildings. First published in 1985, the original basis of the model ordinance was Los Angeles' Building Code Division 88. The model was revised in 1990, 1991, and 1995. It is known now as the "1995 Recommended Model Ordinance for the Seismic Retrofit of Hazardous Unreinforced Masonry Bearing Wall Buildings."

Part of SEAoC's and CALBO's response to the CSSC was to convert the technical provisions of the model ordinance into a format acceptable to the International Conference of Building Officials (ICBO) for use in all seismic zones. The technical provisions of the revised model ordinance became Appendix Chapter 1 to the 1991 edition of the Uniform Code for Building Conservation (UCBC), a companion document to the Uniform Building Code (UBC). The administrative provisions of the model ordinance are not included in the UCBC. In 1991, the State of California adopted the UCBC's Appendix Chapter 1 as a model code.

The issue was referred to an advisory committee, the Seismic Investigation and Hazards Survey Advisory Committee (SIHSAC), which was established about 1980. In addition to engineers and architects, it was composed of contractors, real estate and lending interests, and others. While the SIHSAC generally agreed that the UCBC was an appropriate approach, strong opposition came from UMB property owners, especially those in lower income, rental rate, and property value areas of San Francisco. This led to two important studies — an environmental (and economic) impact report and benefit-cost analyses of UMB rehabilitation alternatives. These reports were used by a largely nontechnical task force (discussed below) to fashion a politically acceptable compromise. The SEAoNC's ad hoc committee recommended that San Francisco adopt California's new model code.

The opposition to the UCBC approach led the Board of Supervisors and the Mayor of San Francisco to form a two-part task force to review the SIHSAC's recommendations. The task force, composed of representatives of several city departments and other organizations (assisted by a 40+ member Community Advisory Committee) recommended allowing the "bolts-plus" approach because, at least for normally configured buildings, this would prevent 80 percent of the URM building earthquake life-safety problem (out-of-plane failure of the bearing walls). Ultimately, this became the political selling point of Ordinance 225-92. Ironically, however, some engineers believe that only a small percentage of all the inventoried unreinforced masonry buildings are actually eligible for "bolts-plus" rehabilitation.

The Loma Prieta earthquake on October 17, 1989, accelerated the process of enacting the UCBC as a state model code (not necessarily a minimum) for rehabilitating URM buildings (Chapter 173 of the 1991 Statutes, which amended several individual state code sections). Meanwhile, the SEAoNC used Loma Prieta's "window of opportunity" to get some significant limits on the use of "bolts-plus" inserted into San Francisco's pending Ordinance 225-92. For example, the "bolts-plus" rehabilitation method cannot be used on a URM building unless it has a regular configuration, has qualifying cross walls, and has a specified minimum area of solid URM wall.

One participant in this process noted that Ordinance 225-92 was "totally driven by socioeconomic issues." Ordinance 225-92 states: "UMBs are vital to San Francisco's economy. They provide low-cost housing, job sites, and irreplaceable historic and architectural resources. Yet, in an earthquake, they pose *a great danger to passersby and occupants." UMB structures also continue to expose low-cost housing to a sudden and permanent loss of habitability after moderate to major ground shaking even though their risk to life is reduced.*

Notices regarding compliance and "inventory forms" were sent to the owners of the governed buildings. Dates for subsequent compliance with the ordinance's rehabilitation provisions were staggered depending on the perceived relative hazards of a building's location, size, and occupancy. Compliance dates ranged from 3.5 to 13 years. If owners do not comply within the specified time period, the city's final recourse is to condemn the building so it cannot be used.

With strong support from the Board of Supervisors, in 1992 San Francisco voters overwhelmingly approved a General Obligation Bond issue of $350 million "to help owners of seismically unstable buildings finance retrofitting. . . . " While required rehabilitation is under way, as of October 1996 little of the money has been committed because: (1) commercial loans or private financing is available in a healthier economy, (2) administrative requirements are too burdensome or add to the potential costs, (3) some owners are postponing work until "the last possible minute," and (4) financing of some projects is complicated because of the need to integrate the seismic rehabilitation financing with other low-income housing financial and regulatory measures.

REHABILITATION POLICY CHOICES: OTHER CASES

Central to the overall purpose of the *Guidelines* documents is the provision of a framework to help users understand and then select desired levels of seismic performance of buildings. As the user will note in Volume 1 of the *Guidelines*, a user must select, for every structure which is a candidate for rehabilitation, a specified level of desired performance. Historically, these types of decisions have been based on preparatory technical studies or, more subjectively, on the feasibility of the rehabilitation. In some cases, the desired performance decisions drew upon an agreed-upon assessment of risk, the existing capabilities of a building to withstand the motions of a projected event, and economic feasibility. Thus, the *Guidelines* documents focus and, in a sense, "discipline" rehabilitation decisions and the selection of target performance levels — from which then flow specific design choices, engineering parameters, and construction techniques.

Case 15: Santa Cruz, California

The city of Santa Cruz was heavily damaged by the 1989 Loma Prieta earthquake and faced a variety of reconstruction problems. A former city planner in Santa Cruz identified 25 post-earthquake challenges to his community, a full 18 of which are directly relevant to issues often encountered in the seismic rehabilitation of existing buildings foreseen by the Guidelines documents. Selected and slightly edited for use here, they are as follows:

- *The jurisdiction may have to add new administrative capacity (hire new staff), which involves both hiring time and learning time.*
- *Economic necessity may require more than simply rebuilding, especially when overlaid with new requirements for safety in retrofit and new construction. Retail trade may need to increase, and infrastructure upgrades may be required.*
- *Planning to rebuild accelerates attention to long-standing problems and issues (some of which will continue to prove intractable). Examples include defining appropriate levels of growth or economic development, upgrading of old infrastructure, and poor political environment (acrimonies, lack of inclusive decision-making processes).*
- *Rebuilding may require shifts in political and/or institutional patterns and habits.*
- *Political imperatives might be at odds with what makes sense from a planning or administrative perspective, which can make the decision-making process complicated and time-consuming.*
- *Special time and effort may be required to set up financial resources (tax measures, grant applications, redevelopment districts). Worse, resources may not be available.*
- *Decision-making may be delayed by the need to obtain information on and learn more about the*

regional economic situation, financial options, development economics and potentials, geologic conditions, construction and design issues, and lender requirements.

- *Political battles can command the time and attention of key actors and delay other decisions (e.g., historic preservation fights over buildings may delay decisions about adjacent properties and affect political discussion of other issues).*
- *New political interests may coalesce and need time to organize (e.g., a property owners association may become a necessity in an area where none existed previously).*
- *The local political system may have difficulty achieving agreement on key planning issues. Old adversaries may have to find common ground. Long-standing interjurisdictional disputes may have to be resolved.*
- *Philosophical differences may surface over the "proper roles" of the private and public sectors.*
- *New roles emerge. For example, property owners with no previous development experience suddenly become developers or a city with a reactive/regulatory orientation toward development may find itself having to solicit, if not court, new development.*
- *The most heavily affected areas may be the least economically viable parts of the community.*
- *Shortcuts are few. Legal and procedural requirements must be adhered to unless special legislation is pursued.*
- *Jurisdictions may have to seek, sponsor, or lobby for special state legislation.*
- *Perceptions of needs change, and planning may go in fits and starts.*
- *Organizing effective citizen participation is essential but takes time and effort.*
- *Displaced businesses and residents must be accommodated while long-term solutions are sought.*

As this list makes clear, pre-earthquake and post-earthquake environments share many characteristics. The difference after a disaster, however, lies in a radically changed legal, regulatory, and political context — especially for seismic rehabilitation. After a major damaging earthquake, financial subsidies for repair and rehabilitation may suddenly become available, emergency authorities may be granted and exercised, and popular and media pressure to "do something" may emerge — all of which create the positive context for action only dreamed of by seismic safety proponents prior to the event.

In sum, earthquakes shoot seismic safety straight to the top of decision agendas, opening windows of opportunity for major advances. The question, of course, is how long those windows remain open before previous societal issues and problems regain their places on the agenda and new ones emerge, pushing seismic safety back down and starting the process all over again.

Perhaps of most direct importance for this discussion, damaging earthquakes may allow a jurisdiction that had been relying on simple attrition or following the lowest conflict model (voluntary) to move more aggressively on the earthquake-vulnerable buildings problem and utilize the "Informal/Encouragement Program" or go all the way to the formal "Mandatory Program."

Local economic conditions at the time of program enactment play a major role in seismic rehabilitation. For example, Los Angeles' Chapter 88 URM ordinance was passed in the "go-go" 1980s, a time of economic expansion and escalating property values, which made the financing of seismic rehabilitation projects easier.

Case 16: Portland and the State of Oregon

In 1993, western Oregon changed from Seismic Zone 2B to Zone 3 in recognition of new information about the risks of a subduction earthquake off the coast. This has had a significant impact on policies relating to existing buildings in that most of them now can be considered "dangerous buildings" because they were designed to a lower seismic standard.

In April 1995, the Portland City Council passed several ordinances that were developed by the Task Force on Seismic Strengthening of Existing Buildings. These constituted an interim policy that was to *remain in effect until March 1997. The first ordinance took seismic loading out of the definition of dangerous buildings in the city's Dangerous Buildings Code. Other ordinances then codified several passive triggers that require seismic rehabilitation to current code or the suggested standard in the NEHRP Handbook for the Seismic Evaluation of Existing Buildings (FEMA 178), depending on the trigger. The following is a brief summary of the triggers:*

- *Changes of occupancy (to a higher standard based on UCBC ranking) and structural additions (that are not structurally independent) require rehabilitation to the current code standards.*
- *Alterations to most buildings valued at more than $100,000 require a FEMA 178 evaluation of the building. The data collected in this manner are to be used in developing the policies to be enacted after this interim period.*
- *Two types of alteration to URM buildings require rehabilitation to the FEMA 178 standard — reroofing (involving removal of the old roof or repair to more than 50 percent of the deck) requires anchorage of the roof system to the exterior walls and bracing of the parapets and alterations in a 2-year period that exceed $15 per square foot for the total net floor area trigger rehabilitation.*

In 1995, the State of Oregon passed SB 1057 which created the Oregon Seismic Rehabilitation Task Force. The legislation directed the task force to provide recommendations to the legislature for its 1997 session. The task force has considered many of the topics important to any jurisdiction considering seismic rehabilitation programs including inventory data, mandatory and passive triggers, design standards, appeals, enforcement, liability, incentives, education and information, coordination and reporting, and needed legislation.

The task force filed its report on September 30, 1996. Legislation to begin implementation of the report was introduced in 1997 but it failed to pass. However, Oregon's legislature created the Oregon Seismic Safety Policy Advisory Council (OSSPAC). It expects to retain a focus on existing earthquake-vulnerable buildings as it considers long-term strategies.

Case 17: The Federal Case

In the 1990 re-authorizing legislation for the National Earthquake Hazards Reduction Program (NEHRP), Congress included a mandate that the President adopt "standards for assessing and enhancing the seismic safety of existing buildings constructed for or leased by the federal government." This one clause made the Executive Branch face the same issues that confronted so many private-sector building owners and local building officials — performance levels, priorities, scheduling, trigger mechanisms, funding, and others – but on a larger scale of course.

There was a very wide variance in cost estimates because of a lack of reliable data. The solution was therefore to adopt two parallel courses:

- *Seismic rehabilitation is required for owned or leased buildings under a set of prescribed conditions ("triggers") when the upgrading of a building for other reasons will cost more than 50 percent of its replacement value and*
- *Collection of reliable cost data on which to base a more extensive, structured, and cost beneficial program of seismic rehabilitation also has started. In effect, this is a "Mandatory Program" model but one that is being implemented in an incremental and cautious manner pending the development of more reliable data on which to make such a significant public policy decision.*

Implementation has begun. On December 1, 1994, President Clinton signed Executive Order 12941. This significant policy action, titled "Seismic Safety Of Existing Federally Owned Or Leased Buildings," established minimum seismic rehabilitation standards for "existing buildings constructed for or leased by the federal government which were designed and constructed without adequate seismic design and construction standards." While the Order establishes standards, a loophole is provided from what is an internal federal mandatory program. Under Section 3, "Implementation Responsibilities, federal departments and agencies are allowed to "request an exemption from this Order from the Director of the Office of Management and Budget." The conditions under which an exemption would be granted have not been defined, and no exemptions had been *requested or approved at the time this publication was prepared. The results of this assessment could lead to a more active seismic rehabilitation program among federal agencies. Moreover, publicized upgrading of federal buildings in many communities might trigger greater attention to and action by local governments, building owners, and others with a stake in seismic rehabilitation.*

BENEFIT-COST ANALYSES

Expenses associated with seismic rehabilitation are never trivial, largely because the basic structural frame of a building is at issue. In addition, many nonstructural and mechanical/electrical systems must be enhanced commensurately. Thus, the question of benefits justifying the costs keeps creeping into the discussions. Benefit-cost analysis can help overcome owners' initial resistance to investing in seismic rehabilitation in that it provides a structured way to compare the longer term benefits to be accrued when compared to the sometimes seemingly high initial costs.

Seismic rehabilitation costs money and money is scarce (by definition) but someone has to pay for it. In applying the *Guidelines*, a benefit-cost analysis is one way to link together and compare risk, expected building performance, estimated direct losses (including property damage, relocation costs, and losses in inventory, sales and rental income) with long-term benefits (the avoided future damage and ancillary losses) so that intelligent, or at least in formed, choices can be made about investing in rehabilitation. In the private sector, return on investment is another important factor that must be taken into account.

Case 18: The FEMA Benefit-Cost Modelling

FEMA has been addressing the fundamental "is it worth it" question since 1989 by supporting the development of basic benefit-cost methods, including manuals and software, that will help users analyze seismic rehabilitation possibilities. The models provide default values for key variables, but they explicitly urge users to provide ("plug in") more accurate and detailed local information whenever possible.

FEMA's initial efforts comprised two benefit-cost models for application primarily to privately owned buildings. The first focuses on single classes of buildings (e.g., URMs), and the second aggregates the results of several single classes to facilitate rehabilitation decisions about an entire area (e.g., Pioneer Square in Seattle or Old Sacramento in California). Additional cost data are contained in another FEMA document, NEHRP Guidelines for the Seismic Rehabilitation of Buildings: Example Applications (FEMA 276), expected to be available by mid-1998.

In essence, a benefit-cost analysis of the seismic rehabilitation of a building requires a cost estimate of the rehabilitation plan (always the easier part) and a probabilistic estimate of future benefits (more difficult). Benefits are calculated on a net present value basis to account for the time value of money. They also depend on the expected annual probabilities of future earthquakes and estimated "avoided losses." Those estimated avoided losses include building repair or replacement costs, damage to contents and inventory, relocation costs, lost income, and the monetary value of avoided deaths and injuries (based on a "statistical value of life"). The benefit-cost ratios tend to be high (favorable) when the building is of a hazardous class, the estimated cost of rehabilitation is modest, and the annual probability of earthquakes is high.

The appropriate FEMA publications and software are a pair of two-volume sets: A Benefit-Cost Model for the Seismic Rehabilitation of Buildings (FEMA 227 and 228, 1992) and Federal Buildings: A Benefit-Cost Model (FEMA 255 and 256, 1994) which also includes methods for estimating the value of public services.

In addition, a useful companion two-volume reference is available from FEMA — the second edition of Typical Costs for Seismic Rehabilitation of Buildings, Vol. 1, and Supporting Documentation, Vol. 2. The new edition is based on a sample of 2,000 seismic rehabilitation projects throughout the country that were carefully screened and their cost data analyzed by sophisticated statistical techniques. In addition to mean cost figures, Volume 1 offers the user three optional methods of calculation, each yielding results that have variances that become smaller as *knowledge about the basic characteristics of a single building or an inventory of buildings increases. Volume 2 provides the statistical underpinning of the data and information on additional costs associated with the nonstructural and administrative activities of a rehabilitation project. There already has been strong demand for these volumes, and their use is expected to grow considerably with time, especially as the implementation of Executive Order 12941, gains momentum.*

In conducting benefit-cost analyses, it is important to recognize that rehabilitation costs can vary significantly. Such variations can be attributed to local economic conditions, prevailing wages, use of union or nonunion labor, times of day and days of week when work can be done, the extent of other upgrades required, the costs of finishes, and similar items familiar to those in the design and construction industries. In fact, the ancillary and "business interruption" costs of a major seismic rehabilitation project could actually exceed the direct costs of design, teardown, construction, permitting, etc. See Chapter 4 for an examination of potential societal issues by explaining the nature of each problem, typical issues that may need to be addressed, and various ways of solving each problem.

BUILDING OFFICIALS: THE EYE OF THE STORM

A jurisdiction's building officials are central under any of the three models and in any effort at seismic rehabilitation. Sooner or later they will be involved either actively or passively. To explain, a weather metaphor might be appropriate. Keeping in mind the increasing conflict potential in the three models, we can think of attrition as normal weather. The "Voluntary Program" is then a tropical depression and, the "Informal/Encouragement Program," a tropical storm. The "Mandatory Program" is a full blown hurricane. The building official is the constant, however, for he or she remains in the eye of the storm regardless of its size. In fairness, design professionals can become caught up as well.

Consistent with this perspective, a researcher once tried to contact the head of a building and safety department who was directing the preparation of a draft hazardous structure abatement ordinance (i.e., this was a "Mandatory Program" case) and was taking an incredible amount of political heat as a result. Everybody was after him, and he was running from meeting to meeting. Not much can be done about the number of must-attend meetings for a building official involved in a "Mandatory Program," but one of the great virtues of the *Guidelines* documents is that, to return to the weather metaphor, these at least provide a sea anchor to the building official caught in the hurricane.

SPECIAL CIRCUMSTANCES AND WINDOWS OF OPPORTUNITY

It is almost a cliche to say that damaging earthquakes open "windows of opportunity" for advances in earthquake safety, but this is an actual truism for seismic rehabilitation. In California, still the perennial source for illustrations, in addition to code changes for new construction, both statewide and jurisdiction-specific seismic rehabilitation legislation came as direct results of various earthquakes from Long Beach 1933 through San Fernando 1971 to Northridge 1994.

While the *Guidelines* documents do not and are not intended to address the complicated issues involved in repairing earthquake-damaged buildings, pre-earthquake seismic rehabilitation of existing buildings and post-earthquake retrofitting of damaged buildings achieve the same purpose — lower risk to life and property. From a socioeconomic perspective, many of the same problems arise, and some wisdom can be exchanged. For any community considering seismic rehabilitation, the issue of what to require of new buildings always surfaces in discussions of what to require of existing ones. While the *Guidelines* documents offer several performance levels for rehabilitated buildings, many communities, especially those in lower risk seismic zones, will obviously be unlikely to apply to old buildings standards that exceed those required of new construction. Therefore, the core of an acceptable program may be correcting "fatal flaws" (those identified by the engineer and the building official) in various classes of existing buildings.