OES CALIFORNIA

Governor's Office of Emergency Services

Earthquake Program

INCENTIVES AND IMPEDIMENTS TO IMPROVING THE SEISMIC PERFORMANCE OF BUILDINGS

EERI

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JUNE 1998

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INCENTIVES AND IMPEDIMENTS TO IMPROVING THE SEISMIC PERFORMANCE OF BUILDINGS

A REPORT PREPARED BY EERI FOR CALIFORNIA OES

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PREFACE

This paper had its genesis several years ago in the minds of some leaders of the Structural Engineers Association of California (SEAOC). In 1995 they wrote a paper, "Natural Hazard Reduction Incentives—An Implementation Program" (Cocke et al. 1995), calling for the various stakeholder groups concerned with improving the seismic performance of buildings to come together. They advocated discussions among the leaders of these stakeholder groups to stimulate the development of appropriate incentives. This paper was circulated widely and a number of organizations expressed interest in participating in such discussions.

At about the same time, some of the members of the Earthquake Engineering Research Institute (EERI) were discussing the need for a better understanding of the impediments to improved seismic performance of buildings. Thus SEAOC and EERI began meeting and identified a strategy for working on both incentives and impediments. This strategy involved bringing together representatives of some of the stakeholder groups to contribute to an analysis that would clearly lay out the major issues—incentives and impediments alike—facing building owners.

Also interested in these same issues was the California Governor's Office of Emergency Services Earthquake Program (OES). In 1997 they agreed that an appropriate first step was to constitute a small steering committee of knowledgeable individuals to prepare an issues paper that could be used as the starting point for further discussion and action. The OES Earthquake Program provided EERI with the funding to support such an effort.

This paper is the result. It is written for individuals who promote earthquake mitigation, either at the governmental or organizational level. It is our attempt to inspire and bring together stakeholder groups who can identify how best to motivate building owners to improve the seismic performance of their buildings.

Retrofit bracing in unreinforced masonry building. (Photo: California Governor's Office of Emergency Services, Coastal Region)

EXECUTIVE SUMMARY

This document grew out of interest by the Structural Engineers Association of California and the Earthquake Engineering Research Institute in improving our understanding of both the incentives for owners to improve the seismic performance of their buildings, and the impediments to their doing so. With funding from the California Office of Emergency Services Earthquake Program, a small steering committee was convened to prepare this issues paper; it is intended to stimulate discussion and to serve as the starting point for actions to improve the incentives available.

This paper argues that the decision to improve the seismic performance of a building involves a complex process. After examining many different situations and interviewing a range of building owners, the committee realized that no two buildings go through precisely the same process. The context in which each decision is made is particular to each owner. The objectives of the owner, his/her/its financial circumstances and incentives, and the function of the building all differ from one owner to the next. Inevitably, each building owner considers specific trade-offs in a unique way.

A building owner makes many decisions about a building, the decision about improved seismic performance being but one of them. Seismic performance is evaluated along with decisions about maintenance, up-grading, future investment, and risk management. Owners have essentially four options in managing earthquake risk: (1) retaining, or self-insuring the risk; (2) mitigating the risk through improving the seismic performance of the building or other loss control measures; (3) purchasing insurance; and (4) externalizing (passing on) the possible losses to other parties (through government disaster assistance, for example).

The Decision-Making Context: Key Considerations

Improving the seismic performance of a building is not always the optimal choice. For some buildings the expected economic benefit is too low, perhaps because market conditions are not right, the type of structure difficult to retrofit, or the perceived risk not great enough. This paper identifies the myriad considerations that influence a building owner making the decision to invest in better seismic performance:

- Type of ownership (public, private, non-profit)
- Structure type (its use, construction material, date of construction, occupancy)
- Level of risk (hazard, vulnerability)
- Legal liability (perception, responsibility)
- Profile of the decision maker (owner/

occupant, speculator, risk-averse, risk-taker; financial objectives and goals; experience as developer; advisors)
Occupancy during retrofit (is building currently vacant?; will there be 100% displacement?; who pays relocation costs?)
Market and economic conditions (is real estate slow, flat, or booming?; can enough product be sold to cover debt for retrofit?; debt capacity of building; expected economic/business interruption)
Regulatory requirements (triggering of other codes; use of regulation as incentive—fee waivers, zoning; policies and practices requiring leasing and purchase of seismically resistant buildings)
Information, disclosure, technical assistance
Costs (direct costs, indirect costs, opportunity costs)
Benefits (financial benefits, other benefits)
Financial Aids (tax policy, grants, loans, subsidies)

- Insurance (as impediment; as incentive)

Highlighted for each of these considerations are potential impediments to, and incentives for, improved seismic performance. In the final section, the paper sets out a series of recommendations for new or more effective incentives to improve the seismic performance of buildings.

Changing the Context: New and Better Incentives

Build on Current Incentives

Throughout this paper are examples of currently used incentives. While these examples are primarily from California, such programs could be modified and adopted in any state. By adopting a number of these incentives together, it is possible for public and private sector organizations to create a stronger program.

Public Sector Incentives

- Community-based education and technical assistance programs
- Density bonuses
- Fee waivers
- Modifying parking requirements and other restrictions
- Transfer of development rights
- Formation of hazard abatement districts
- Formation of redevelopment districts or historic districts
- Technical assistance
- Tax increment financing
- Subsidies for engineering analyses
- Loan programs
- Disclosure of earthquake risk, particularly at time of sale

Private Sector Incentives

- Subsidy for design study
- Donated engineering design, labor, materials
- Identification of hazard areas and vulnerable types of structures
- Loans
- Insurance

Encourage Investment in Seismic Performance

Education, information dissemination, and technical assistance are critical to decisions to improve seismic performance of a building. More organizations could provide owners and other stakeholders with the necessary information and help.

- Federal, state and local governments should lead by example and seismically strengthen their own structures in a visible manner.

  Encourage owners to take advantage of positive conditions at various points throughout the life of a building to improve its seismic performance.
  - ✓ Upgrade when the building is vacant
  - ✓ Upgrade as part of a larger remodel
  - ✓ Upgrade as part of scheduled maintenance
  - ✓ Upgrade in a booming economy
  - ✓ Upgrade when the building has the ability to carry additional debt
  - ✓ Upgrade when the market for the building, product or service has the ability to cover the costs
- Continue to develop educational materials/programs that help owners gain a better understanding of the risk.

  Encourage the development of building inventories that local governments and, ultimately, building owners can use in their risk management decisions.
- Encourage the development and widespread use of learning from earthquakes programs, working through professional associations and colleagues.

  Develop an ombudsman program at the local or state level that helps owners through the entire process of improved performance.

Create More Effective Incentives

- Further research is the first step in determining the look of the following types of incentives. This research should be a high priority in states with vulnerable buildings and at the federal level.

  Encourage lenders to accept greater responsibility in promoting the improved seismic performance of buildings. This could include requiring evidence of improved performance before issuing a mortgage; requiring PML studies for all investments; offering discounts for improved performance, such as reduced points or a lower loan guarantee fee; and increasing the loan-to-value ratio to 85 percent so that borrowers could use the additional 5 percent to improve the seismic performance of their buildings. Lenders should also be encouraged to add the costs of improving the performance of the building to the loan, requiring buyers to perform the work within a time limit.
- Encourage other stakeholders, particularly design professionals and regulators, to support lenders and insurers by providing technical information, and by recognizing and understanding the place of seismic safety in the lenders' and insurers' investment decisions.
- Encourage insurers to support the improved seismic performance of buildings. If changes in insurance policy require regulatory or other policy changes, other stakeholders should work with the insurance community to insure such changes take place. Recommended policy changes might include promoting the passage of earthquake insurance that requires mitigation, or offering discounts for improved performance.
- Encourage insurance regulators to support the goal of improving the seismic performance of buildings, and to modify

regulations to allow insurers to develop policies that reflect this goal.

Encourage states and the federal government to evaluate carefully the impact of various regulations and policies on improving seismic performance. Some existing regulations act as impediments, including the disaster assistance law, bonding limitations and federal tax law. The impact to the treasury and/or to taxpayers of removing these impediments needs to also be evaluated.

Encourage states and the federal government to develop effective tax incentives for improved seismic performance. This might include a 10 percent tax credit, accelerated depreciation for retrofit work, deductions for retrofit work (as opposed to just deducting for losses after an earthquake). In order to develop these incentives it is clear that additional research needs to be conducted on the impact of such tax changes on state and federal treasuries. Such studies should include the costs to those treasuries of earthquake response and recovery if building performance is not improved.

Encourage states and the federal government to investigate the feasibility of a revolving loan fund to finance mitigation work. Such a loan fund could be supported primarily by funds from the borrowers.

The Next Steps

Conduct a Workshop

In order to maximize the probability that a set of incentives can be developed and adopted, we propose a workshop with invited representation from all the potential stakeholders. This workshop would bring together policy setters from the insurance industry, lending institutions, design and construction professionals, the regulatory communities, government agencies, private and public sector information providers, and representatives of tenants and employee groups. Participants at the workshop would work toward setting a national agenda for the development and implementation of an effective set of incentives for the improved seismic performance of buildings.

Coalition Building

Emerging from the workshop would be a stakeholders coalition interested in developing better incentives and removing impediments. As it coalesces, the coalition would act as a strong advocacy group for mitigation. Each of the stakeholder interests (owners, lenders, insurers, design professionals, government regulators, information providers, tenants) will be an active participant in the development of incentives, and will have networks, professional associations, and colleagues to lobby and/or involve in the discussions on regulations, procedures or practices. This coalition could develop a blueprint for improved seismic performance of buildings that would be available to state and local governments as well as to organizations in the private sector.

INTRODUCTION

For years earthquake professionals have been discussing how to motivate people to take action to reduce seismic risks. One of the obvious ways to reduce losses in earthquakes is to make buildings more able to survive the shaking and related ground motions. There is general agreement that more mitigation action (for the purposes of this paper, improving the seismic performance of a building) is needed if losses of life and property are to be reduced. But why are some building owners mitigators, and others not?

This paper describes the context in which building owners make decisions to improve the seismic performance of buildings. It proposes a model of the decision-making process—the key considerations and stakeholders that make up this decision context. By clearly identifying such major considerations and the interaction among them, we hope to gain a better understanding of how incentives and impediments influence the process. This, in turn, allows us to identify a set of incentives that may be particularly useful in promoting seismic mitigation for buildings.

This report is intended for individuals who can facilitate and promote earthquake mitigation at the governmental and organizational levels. It provides a general discussion of the complex array of issues and considerations that can affect a decision to invest in earthquake mitigation. This can be useful in understanding both how to influence the adoption of mitigation through the development of incentives, and how various impediments may prohibit such adoption.

It is important to point out up front, that in the early stages of this project, steering committee members and staff thought that the product would be a list of powerful incentives that would encourage most building owners to improve the seismic performance of their buildings. However, after discussion and reflection, it became obvious to the project participants that the decision to improve the seismic performance of a building is very complex. Explaining the complexity of the decision is one of the purposes of this paper.

It is important to acknowledge that mitigation is not always the rational decision, given competing factors such as other risks, other investment opportunities, business issues, and the perceived level of risk. This paper hopes to clarify how each of these factors contributes to the ultimate decision.

The focus of this paper is on the mitigation investment decisions that go beyond what is legally required. There are codes and regulations in some states and communities that require incorporating certain

■ *"We are seeing more and more lenders in particular interested in the expected seismic performance of buildings. The financing requirements are driving voluntary upgrades. Lenders making large loans are interested in reducing the 'damageability' of the buildings in their portfolios, and are requiring owners to improve the seismic performance. An issue with this increased interest in performance is that there are currently no standards for how the required analyses (probable maximum loss {PML} studies) should be performed. Currently the American Society for Testing and Materials has a subcommittee for seismic review that is identifying standards for PMLs[1]."*

Washington Engineer

seismic design features in new structures, or strengthening certain types of existing buildings. Many jurisdictions requiring seismic retrofits have seen fit to include incentives for owners to develop a stronger partnership with governments. While there is some discussion of these mandated programs and incentives, this paper focuses on owners who are voluntarily considering ways to address the seismic risk in their buildings.

This paper builds on a number of earlier studies that identified possible incentives and how they might influence mitigation action. Among them are the FEMA-sponsored three-volume study, *Financial Incentives for Seismic Rehabilitation of Hazardous Buildings* (Building Technology Inc. 1990a, 1990b, 1991), that described, "the existing and potential regulatory and financial mechanisms and incentives in the private sector, at the federal level, in six states and fourteen local jurisdictions that can reasonably be used in a course of action to lessen the risks posed by existing buildings in an earthquake."

More recently, the National Association of Public Administration (1997) commissioned a study of options for applying standards of seismic safety in federal buildings through aid and regulatory programs. This study produced a set of recommendations, as well as workshop summaries and major points from dialogue groups, that were useful in preparing this report.

In addition to these two major efforts, other reports have dealt with the need for incentives and for more detailed examinations of how building owners can be convinced to strengthen existing buildings

[1]A PML is the expected maximum percentage monetary loss which will not be exceeded for nine out of ten buildings in a given class of buildings.

(Bay Area Regional Earthquake Preparedness Project 1992; Building Seismic Safety Council 1997; FEMA 1993; Hamburger 1997; Olshansky and Glick 1997).

The Building Owner

The "building owner" is often a very complex concept in both the private and public sector. Defining the building owner and the relevant decision process for earthquake hazard mitigation investment is necessary before crafting policy to influence that decision process. The owner may be an individual or a corporation. It is critical to understand the normal facilities management process of an organization as it relates to building acquisition and maintenance. It is also necessary to understand the facilities budget process of an organization and how it relates to capital expenditure and maintenance. In many organizations, the facilities management structure does not interact directly with the risk management structure (Krimgold 1998).

■ *"In a building owner's mind, what to do about a building's expected seismic performance is one piece of a much larger puzzle."*

California engineer

Improving the seismic performance of a building is a complex process. Examination of many different situations and interviews with a range of building owners make it clear that no two buildings go through precisely the same process. The *context* in which each decision is made is a major determinant. The objectives of the owner, his/her/its financial circumstances and incentives, and the function of the building differ. Inevitably, each building owner must consider trade-offs unique to his/her/its own circumstances.

■ *This structure, located in the South of Market area in San Francisco, is a multistory warehouse built in the 1920s. The new owner wanted to add one more floor to the building and to convert existing space into offices. According to the San Francisco Building Code, in cases of vertical or horizontal additions to existing buildings, and/or changes in occupancy, the building must comply with what was then known as Section 104(f), which establishes minimum criteria for lateral force resistance. Structural engineers thus faced two problems—improving the seismic performance of the existing structure, while incorporating seismic resistance into the design of the additional floor. Many constraints were imposed on structural decisions for purely architectural reasons, such as positioning a new elevator and staircase shafts. Total construction costs in 1987 dollars were estimated at $1,900,000, including architectural and engineering fees.*

(Photo and text adapted from Bay Area Regional Earthquake Preparedness Project 1989)

A building owner makes many decisions about a building, and the decision about improved seismic performance is but one of them. Improved seismic performance can be evaluated along with decisions about maintenance, upgrading, future investment, and risk management.

To illustrate how prominent (or not) the expected seismic performance of a building is in a decision regarding a building, consider the example of a lender who evaluates buildings in a large portfolio. The technical and environmental aspects of a building are reviewed together—including hazardous materials (lead and asbestos), contaminated soils, storage tanks, accessibility, the building systems (mechanical, elevators, electrical), cladding, and the structural system. Within the evaluation of the structural system, which is itself only one consideration along with all the above variables, is the expected seismic performance of the building.

Building owners must make decisions about managing risks posed by hazards such as fire and earthquake. These risks include physical losses, such as the loss of a building; and economic losses, such as the loss of customers, stock, or production capability. Building owners have essentially four options in managing earthquake risk: (1) retaining or self-insuring the risk; (2) mitigating the risk through improving the seismic performance of the building or other loss control measures; (3) purchasing insurance; and (4) externalizing (passing on) the possible losses to other parties.

■ "Seismic issues are rarely the sole consideration for the scope of a change or addition to an existing building. Seismic performance evaluation and improvement may be secondary considerations of a major remodeling effort undertaken for any number of reasons. Even if seismic performance improvement is the primary motivation, it is wise to consider a broader potential scope at the beginning of the project. Potential considerations include the following:

Fire and life-safety improvements

Hazardous material abatement

Disabled access improvement

Change in programmatic use

Functional improvements

Building system improvements

Historic preservation

Some of these are voluntary and may simply make sense to include. Others may be required by law when changes are made to a building."

(Applied Technology Council and California Seismic Safety Commission 1996, 2-6)

These options are not mutually exclusive—a building owner may employ a combination of these measures. If the risk seems too large or unmanageable, the owner may decide to sell a building or reduce its occupancy. On the other hand, damages to a structure may impose certain social costs that are not considered by the property owner in his/her/its risk management decision.

Society

Individual owners make choices about earthquake risk and the performance of their buildings. Society is concerned about the overall impact of earthquakes and the performance of many buildings. If earthquakes only affected a handful of buildings, it is unlikely that society would be concerned about improving the seismic performance of buildings. The decision to improve the seismic performance of a building would be primarily a private decision and the need for additional government-provided incentives and regulations would be diminished.

However, widespread damage to a number of buildings can impose significant social costs, impairing a community's ability to function and generating pressure for government to provide assistance. Consequently, society as a whole—including finance and insurance sectors and governments—has a stake in earthquake risk management and mitigation that extends beyond the private interests of building owners. This requires consideration of an array of possible incentives and regulations that respond to public as well as private interests.

The Owner in Society

In theory, private markets and free choice should result in optimal risk management decisions from the perspective of the property owner and society. However, if property owners can pass off the risk to third parties and/or society, they will not be inclined to invest adequately in mitigation or insurance (Klein 1998). They won't perceive themselves to be personally responsible for much of the risk. Ways that owners can pass off the risk include loan defaults, tax deductions of losses, and use of subsidized disaster assistance. Losses suffered by a building's occupants that are not paid by the building owner and other negative social impacts exacerbate the risk distribution problem. Insurance is not considered passing off risk if the insured pays an actuarially fair premium for the coverage received.[2]

While society (in particular, government) has a strong interest in improving the seismic performance of many buildings, governments unwittingly may actually be creating some impediments to earthquake risk management and reduction. Changing some current government programs that function as disincentives to mitigation is among the policy options that will be considered in this paper.

Plan of the Paper

Figure 1 illustrates the stakeholders and the key considerations in any decision regarding mitigation investment. The center circle represents the stakeholders. At the very center of any decision about improving the seismic performance of a building is the owner. Surrounding the owner are information providers, lenders, regulators, insurers, and tenants, employees, or customers. The ovals around the circle represent the various considerations that may prove important to the stakeholders in any particular decision. Some of these considerations act as impediments and others act as incentives to improve the seismic performance of a building. The considerations and the stakeholders combine in a unique fashion for each building and the owner makes decisions based on the intermix.

Is the owner an individual or a group? Is the owner trying to maximize profit, minimize costs, maximize safety, minimize liability, or some combination? The appropriate or adequate consideration of seismic risk in these arrangements also varies.

The following pages discuss each of the major considerations in the decision context and the key stakeholders' influences on the decision. One caveat is that for real-life mitigation investment decisions, these considerations are not linear. Rather, each influences other considerations, and they relate to each other interactively. For purposes of discussion, however, each is considered independently here.

The final section proposes incentives, based on the observations made in these earlier sections.

[2]Insurance can result in some externalization of risk if some insureds receive subsidies through the pricing structure and fail to pay the full actuarial cost of their coverage.

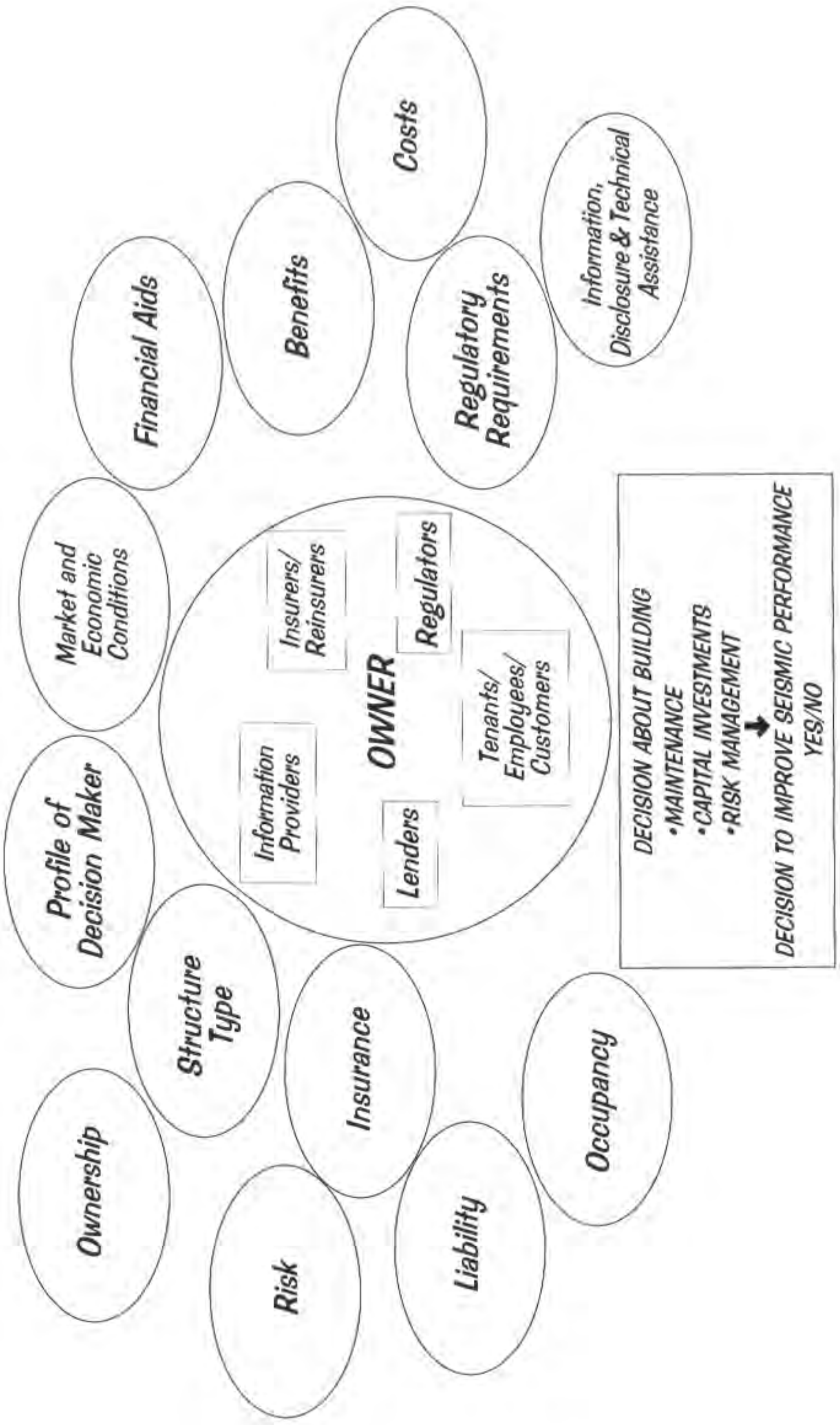


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

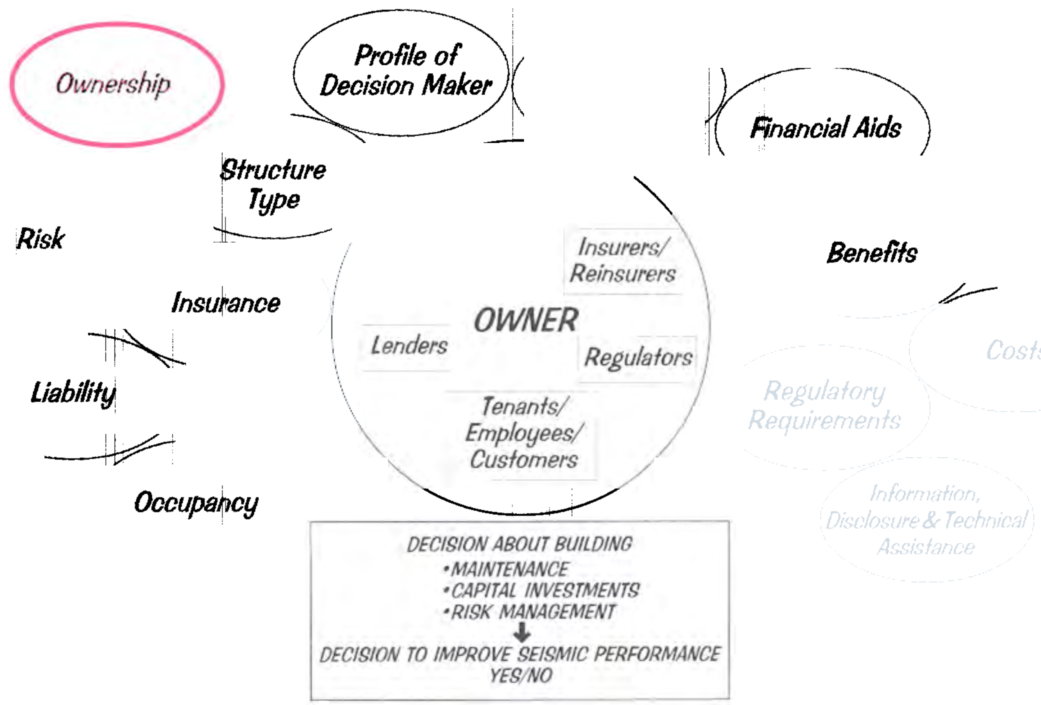


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *The retrofit of the MLK Civic Center Building in Berkeley, California, came up for consideration when several city employees questioned its possible performance after observing midlevel collapses in Kobe's older concrete buildings. Though the building had been seismically evaluated years before, a re-appraisal was thought necessary given new information from recent earthquakes. Working with the University of California, Berkeley created an advisory commission of seismic experts to help evaluate the information. As a public owner that encouraged seismic retrofit in privately owned buildings in Berkeley, city officials assumed their responsibility to upgrade the municipality's administrative center. City employees who were uncomfortable working in the building provided another powerful incentive.*

OWNERSHIP

The owner of a building is an important determinant in the ultimate decision to improve its seismic performance. Ownership can be divided into the three broad categories of public, private, and nonprofit. Public owners include federal, state, and local governmental agencies, special districts, and joint powers. Private owners can include individuals, partners, corporations, ownership as part of a portfolio such as a REIT (Real Estate Investment Trust), foreign owners, and trusts. Nonprofit owners include religious institutions, secular organizations, and foundations.

Public owners are generally responsible to a wider segment of society than a private owner. They may, for example, have responsibility for the safety of school children,

■ *A major computer manufacturing company has an aggressive campaign with seismic design guidelines for new construction and retrofit for its existing buildings. A major presence in California, it also owns or leases buildings throughout the Americas and on several other continents. Decision makers for the company are frustrated when, due to local practice in design and construction, a foreign country won't allow them to construct a building to the life-safety level enjoyed by employees elsewhere. Why should an employee in one country be placed at greater risk than one in another country where the seismic hazard is the same?*

■ *"One of our member companies was seriously damaged in the Northridge earthquake. They had to find a new office. After that, their headquarters (in another state) ordered that all their offices had to meet seismic standards."*

Oregon insurer

university students, hospital patients, and public employees, including emergency workers such as firefighters. Public owners may accept the responsibility, act in a leadership capacity, and set an example for reducing earthquake risk. This may be particularly helpful for states and the federal government, with a large number of visible, important buildings. However, public owners may also be constrained by the availability of public funds to undertake seismic strengthening.

Private owners can range from the homeowner considering the strengthening of a single-story wood frame dwelling to a corporation owning real estate around the world. Many decision makers may be involved in the private owner's decision to strengthen a building, including partners who expect a certain return on an investment, owners from one country that make decisions about a building in another, or committees that are making decisions about a number of buildings in a portfolio or a trust.

Nonprofit owners fall into a special category because they generally make decisions for many people (clients, parishioners) and yet they have very limited or complicated funding choices.

Some buildings have many owners, which may act as an impediment if they cannot agree on how to proceed or how to acquire the needed financing (such as condominium owners or a partnership). Absentee owners may be less likely to make a decision to strengthen a building, or may also have more difficulty in obtaining financing.

■ ***Potential impediments to improved performance, related to ownership:***

- Multiple owners
- Absentee owners

■ ***Conditions that will make improved performance more likely, related to ownership:***

- Desire to set an example for other building owners
- Commitment to safety or business recovery
- Useful for public relations
- Fear of liability
- Desire to maintain market share after an earthquake

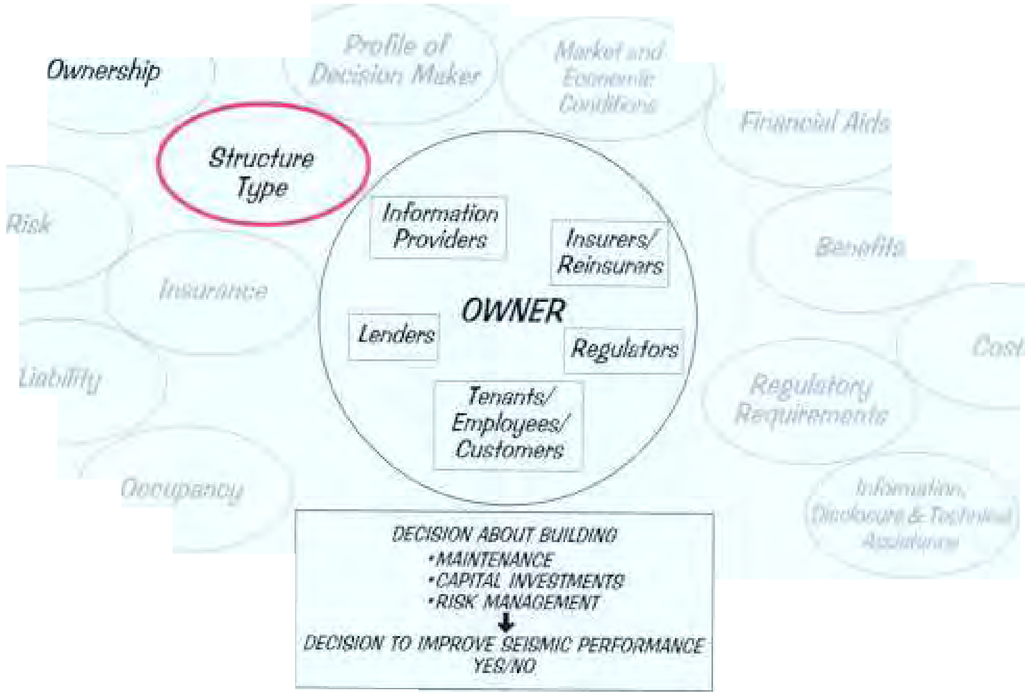


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *In 1975 a Northern California Catholic diocese initiated a sidewalk survey of all of its facilities. Using the University of California at Berkeley methodology, it was able to identify and prioritize over 500 of its church, school, and related buildings. Several of its buildings were unreinforced masonry and many were nonductile concrete buildings. The evaluation identified a number of buildings expected to perform poorly in terms of their expected seismic performance. This started a major mitigation program, beginning with the buildings that received the poorest rating. The mitigation program evolved over years, pieced funding together from various diocesan sources, involved the parishioners in decisions regarding the fate of buildings, and incrementally approached the needed upgrading.*

STRUCTURE TYPE

Important considerations for each structure are its use, its construction material, its date of construction, its historic relevance, and its occupancy. A number of reports help owners and engineers evaluate the seismic vulnerability of a particular structure, including the *NEHRP Handbook for the Seismic Evaluation of Existing Buildings,* FEMA–178 (ATC 1989), and, most recently, the *Handbook for Seismic Evaluation of Existing Buildings: A Prestandard* FEMA–310 (ASCE 1998). This latest publication is intended to instruct design professionals on how to determine if a building is adequately designed and constructed to resist seismic forces. It provides a three-tiered process for seismic evaluation of existing buildings in any region of seismicity and endeavors to reflect advancements in technology and incorporate

■ *Hewlett-Packard's rehabilitation program is driven first, by the need to provide safe buildings, and second, by the intent to limit damage to a defined range in terms of repair time. The company has a seismic policy that requires all buildings in seismically hazardous regions to have a quick evaluation. If any are found not to meet the company's minimum standards, a detailed evaluation and schematic design with cost information is prepared, followed by scheduling the budget and construction phases. Individual business units are responsible for upgrading their own buildings with their own budgets, which may take several years. If a business unit wants a higher performing building, or one with less repair time, that decision requires more management approval due to the exceptional cost of such upgrades.*

professional design experience as well as lessons learned from recent earthquakes. It guides the user in identifying potential weak links in a building through sets of checklists that are organized by building type.

Even without a detailed evaluation of a structure's vulnerability, some of its basic characteristics influence the investment decision. Different uses require different levels of seismic performance. A building such as a hospital, for example, may need to be functional immediately after earthquakes. A building used as a school may be placed at the top of a list of priority buildings for improved performance.

Types of construction materials and configuration also influence the decision to improve performance. Some materials and configurations have historically been found to perform so poorly that some state or local governments may require retrofit by law. Some construction materials represent a high life-safety risk, such as unreinforced masonry, nonductile concrete frames, and early precast concrete structures. Some construction materials also present higher costs to improve expected performance. Wood frame construction in general is less expensive to retrofit than steel frame buildings, for example.

The date of construction and a building's historic significance influence the strengthening decision. Older buildings near the end of their economic life may not warrant much strengthening work. The money might be better used for new construction. On the other hand, if the building is historically significant, it may require careful rehabilitation work.

■ *A Catholic grade school in New Madrid, Missouri, is housed in an unreinforced masonry building. In 1990, Iben Browning predicted the possibility of a large earthquake in the New Madrid seismic zone during the first week of December. The residents of New Madrid were concerned for the safety of their children and developed a plan to reinforce the school. A cooperative effort was established between a consulting engineering firm, the nearby university, a local steel fabricator, and the residents. The consulting engineering firm and university faculty donated consulting engineering services, and the steel fabricator donated materials available from his yard. The materials available from the yard became the major determinant of the engineering design. The engineering consultants inventoried the available materials and developed a braced-frame strengthening plan based on these materials. The fabricator prepared the materials, and the residents donated the labor to install the new structural elements.*

The goal of this strengthening was to prevent the collapse of the building and to ensure that the children could be safely evacuated. The new braced frames were left exposed inside the classrooms and painted bright colors. The exposed strengthening elements give both the parents and the children a sense of security.

(Photo and text: EQE Thiess, St. Louis)

Institutional owners, such as school districts, universities, hospital complexes, and private owners of multiple buildings, often commission building evaluations as the starting point for a decision about improved performance. These evaluations, using the standard methodologies described in ATC-14, *Evaluating the Seismic Resistance of Existing Buildings* (ATC 1987), FEMA–178, *NEHRP Handbook for the Seismic Evaluation of Existing Buildings* (ATC 1989), or FEMA–310, *Handbook for the Seismic Evaluation of Buildings—A Prestandard* (ASCE 1998), can be used to rank the buildings in terms of expected seismic performance. Once an owner receives notification that a building presents significant seismic risk, this can be the impetus to take action that will override other constraints.

Once a building has been evaluated for its expected seismic performance, the owner must decide if the risk is acceptable, and if not, must make a decision as to how to manage the risk. Options include mitigation, disposal of the asset, risk transfer through purchase of insurance, or retention of the risk. If the decision is made to mitigate, the owner must then decide what level of mitigation is appropriate.

FEMA has recently released the products of a multiyear effort to identify guidelines for the seismic rehabilitation of existing buildings, commonly known as FEMA–273. These guidelines provide the designer with a method to deliver the owner's expected risk level (ATC 1997).

Potential impediments to improved performance, related to the structure:

- Building type (can affect cost, difficulty, potential outcome)
- High-density occupancy
- Lack of retrofit standards
- Disruption during retrofit construction
- Cost

Conditions that will make improved performance more likely, related to the structure:

- High-risk occupancy (students, hospital patients)
- Historic relevance

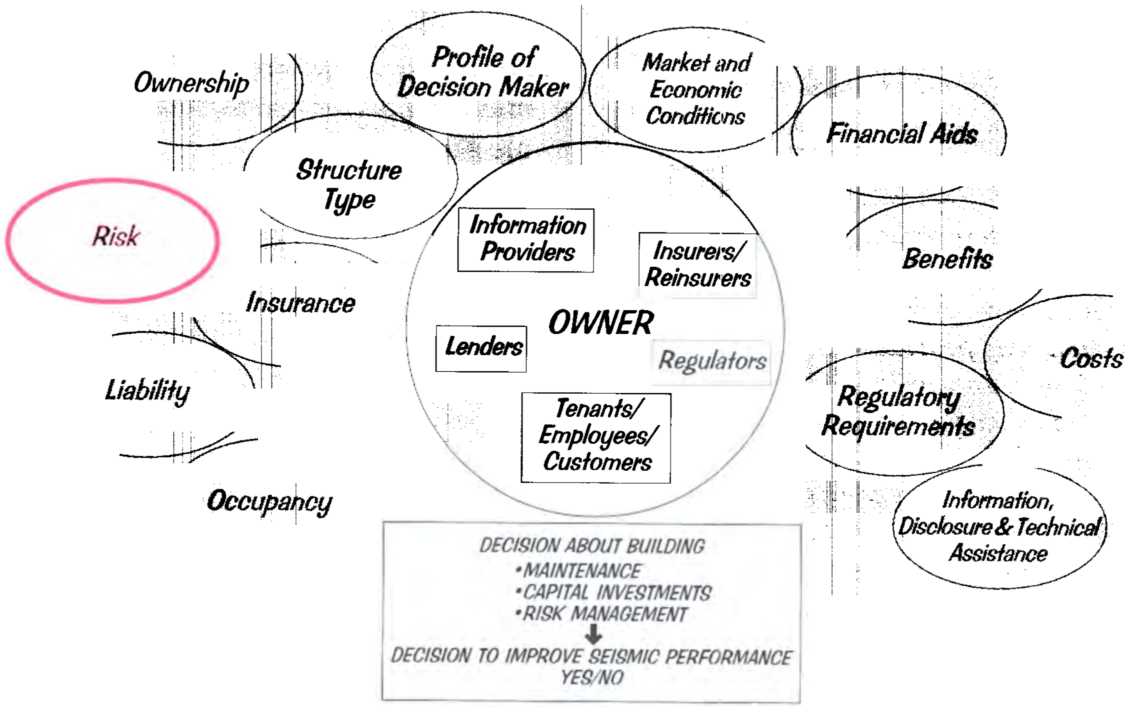


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *With risk managers generally aware of the risk an earthquake could pose to its buildings and the threat of business interruption, a company in the Pacific Northwest had a seismic analysis conducted of all its buildings. This analysis is used to prioritize buildings for upgrading work. Highest priorities for upgrades are assigned to buildings that are rated substandard. Upgrading work is otherwise conducted as an element of general maintenance and scheduled upgrades of other building systems such as mechanical and electrical systems. The buildings are usually upgraded to a life-safety level. Buildings that house critical functions for the business are upgraded to a higher level, so that the company will be operational immediately after earthquakes.*

RISK

Communication difficulties among stakeholders interested in the earthquake problem arise in any discussion of risk. Different disciplines have different definitions for many of the words used. Decision theorists use *risk* to mean the condition "in which the decision maker has a mutually exclusive and collectively exhaustive list of all chance events that exist within the time horizon selected for the decision analysis" (Alesch 1998, 3). *Uncertainty* is the situation in which the information is not complete (understanding of probabilities, for example). Decision making under conditions of risk is quite different from under conditions of uncertainty. *Peril* is the word to describe the event itself (an earthquake). *Hazard* refers to the potential damages and losses a given structure might suffer.

■ *"At the request of an owner, we performed a seismic risk analysis of a commercial development. The purpose of this seismic risk analysis was to provide an assessment of the probable performance of the building during a significant local earthquake. The information was provided in terms of a probable maximum loss (PML) estimate and other pertinent information. The scope of work included a review of available design and construction documents to determine the building's characteristics, a visit to the site to verify as-built conditions, preparation of an estimated probable maximum loss for three scenario earthquakes, and retrofit options to enhance the building's earthquake performance. The owner requested this information voluntarily because of his recent understanding of the potential earthquake risk to both life and property."*

California engineer

However, to engineers, earth scientists, and other earthquake professionals, *hazard* refers to the earthquake itself and *risk* refers to the potential damages and losses caused by an earthquake (hazard, vulnerability, and exposure). *Vulnerability* refers to the degree of loss or damage to particular structures, or segments of society. For purposes of this discussion, the definition of risk we will use is that of engineers and other earthquake professionals—the potential damage and loss associated with an earthquake.

Assessing the risk of earthquakes involves evaluating probability, frequency, exposure, and consequences (FEMA 1997a). *Probability* is a measure of how often earthquake shaking of a given intensity is likely to occur at a particular location; *exposure* defines the number of people and the amount, types, qualities, and value of property at the location; and *consequences* are the impacts to people, property, and the community that may result from an earthquake.

Another aspect of understanding risk is identifying socially acceptable levels of risk. In a recent discussion of risk, the Board on Natural Disasters pointed out that seismic risk needs to be compared with threats from other hazards (e.g., flooding, hurricanes, water and air pollution) and weighed against pressing social and economic needs (e.g., education, health care, housing). If increased resources and attention are devoted to earthquake hazard reduction, then fewer resources are available to meet other needs. This is a difficult choice. The report goes on to say:

> The notion that there can be an "optimal" level of seismic risk has not been developed adequately. Clearly, seismic

■ *A massive historic structure on a state university campus, used by students and faculty during the day and at night by a more general population for special events, fell into disrepair. The earthquake hazard in the community is high; the vulnerability of this particular structure is high. A major fund-raising campaign was initiated to raise money to remodel the hall. No funds were available from the state. The estimated costs of the remodeling, with no seismic strengthening, was $12 million. Money was raised from donors, but with restrictions put on the funds that they could only be used for cosmetic repairs, or more visible improvements. No one wanted to finance seismic strengthening. Because such funds were not available, university administrators went ahead with the remodeling, implicitly accepting the level of risk in the community. Several years later the Northridge earthquake struck, causing over $25 million in damage to the building, and resulting in a major strengthening and repair project that required closing the building for several years.*

risk reduction must be placed in a context developed by balancing the enhancement of public safety and property protection against a wide range of social and economic concerns. This balancing act is especially troublesome when an earthquake could be catastrophic but the probability of a high-intensity event is low or uncertain (Committee on Earthquake Engineering 1997, 7).

The Earthquakes

Basic information about expected earthquakes is fundamental to understanding the risk: how likely is it that one will occur; how frequently; where is it likely to occur; what is the expected magnitude; how widespread will it be felt; how strongly will the ground shake; will it cause associated landsliding or liquefaction? Many owners and decision makers underestimate the earthquake hazard in their community, assuming it can never (or at least not in their lifetimes) happen there, or that it won't affect them if it does. One component in evaluating the earthquake risk is understanding the risk in the context of other risks facing an owner or a community.

The Building

The exposure to potential loss and the consequences associated with earthquakes are also important components of understanding risk. How vulnerable is a particular building or community to earthquakes? How are the buildings expected to perform? What are the consequences of some percentage damage or loss? What happens to tenants or occupants? Is the building able to continue functioning? What are the consequences of not functioning?

■ *Prior to the Loma Prieta earthquake, administrators at Stanford University had begun to develop a long-range strategy for improving the seismic performance of their facilities. The priorities were based on input from a well-informed faculty about the risks associated with particular buildings. The plan was to integrate seismic retrofitting with other needs for maintenance and improvements, wherever possible relying primarily on funding from facilities reserves. Loma Prieta greatly accelerated the campus-wide rehabilitation program. Damage from the event demanded repairs. Local government required life-safety retrofits for many buildings. Finances were bolstered by federal disaster assistance, a major fund-raising campaign, and borrowing. Project needs, and costs, routinely extended beyond seismic repairs or structural improvements. Disabled access, fire protection, exiting, and other deficiencies were addressed. Facilities were updated to meet better their programmatic functions. The historic character of many of the buildings was preserved during the process. The need for improved seismic performance catalyzed a facilities renewal program.*

One must consider that risk is not distributed evenly. It is higher in more vulnerable locations and more vulnerable structures. Some segments of the population are more vulnerable than others in terms of their ability to recover physically or financially, for example, the elderly and the low-income. Even two buildings located next to each other can have different levels of risk associated with them. For example, one building could be sitting on softer soils or have a complex configuration, either of which could make a building more vulnerable to damage during an earthquake. For two identical buildings on identical sites, the owner of one building could be more vulnerable than the other if the first building were mortgaged to the maximum and the other was not. For the owner of the fully mortgaged building, there would be no flexibility to borrow money needed for repairs after an earthquake, putting that owner at greater risk of loss due to an earthquake.

The function of a building also influences the level of risk exposure in an earthquake, both to human life and to economic loss. If identical structures on identical sites have different uses, the risk of loss from an earthquake will be different—compare a partially filled office building to a hospital, for example. Even within a building, risk can be higher for some occupants than for others: an elderly tenant in an apartment building, living on a small, fixed income has more to lose than a young professional with more financial resources. The elderly tenant's loss is more likely to be permanent and result in a lowered standard of living. Risk can be exacerbated or decreased by land use and siting policies. Decisions to allow building on unstable slopes or areas subject

■ *The Diocese of Oakland, California, uses a two-phased approach when identifying the vulnerability and risk of its structures. The facilities management department begins by using a prequalified California licensed structural engineering firm to perform a two-phased rapid evaluation, as outlined in ATC–14 and FEMA–178. Sometimes the weaknesses and vulnerabilities found in the Phase I study can be taken care of without further evaluation. For example, if a building were found only to require additional sheathing of its cripple walls, or strengthening of its roof diaphragm, this could be taken care of without further study. In some cases the work would be conducted as a separate retrofit project; in other cases it would be noted in the database as needed and phased into the regular maintenance of the building. Only if the initial evaluation found something complex or difficult would a Phase II study be initiated.*

to liquefaction increase the risk at the time of an earthquake. Steering development away from such areas through land use policies can reduce risk.

In addition to a building's direct exposure to loss and associated consequences, there are also secondary and tertiary effects. The loss of a particular building can affect other segments of the broader community. The loss of one business may affect other businesses and have economic impacts on clients, suppliers, and employees.

The Community

It is important to consider a community's vulnerability, and the social, economic, and financial consequences of earthquakes there. What happens to a community if a certain percentage of buildings are lost or seriously damaged? What is the expected loss of life and injuries? What about public health impacts? What is the cost of dislocation or business interruption? What is the potential cost of lost production capability? What is the expected loss of employment? How are the lifelines (transportation routes, water, power) expected to perform? What are the implications of being without such lifelines for a few days or weeks? What is the cost of repair? What are the opportunity costs for that money? What about the loss of historic buildings or the historic fabric of a community? What will be the loss to the tax base and the impact on local, state, and federal governments?

The Bill Payers

Risk can be borne privately by individuals or firms, collectively by society, or in some combination thereof. And if individuals can pass off risk to other parties (through insur-

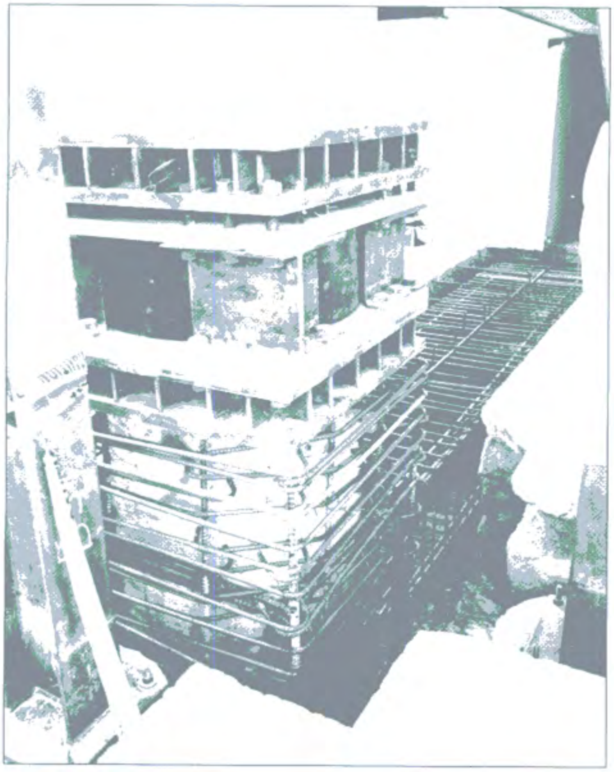
■ *Even when confronted with the direct experience of an earthquake it may still be difficult for some owners to believe it is a risk to take seriously. A California structural engineer, described his experience after the 1971 San Fernando earthquake: "After the 1971 earthquake when we had a tremendous number of tilt-up buildings where the roof was pulling away from the walls, I went to the owners of some of the tilt-up buildings I had designed and told them about the hazard.* ***They just weren't interested****. I said I would pay [for the retrofit] if they wouldn't; that made* ***some*** *of them do it."*

ance, by relying on federal disaster assistance) and avoid paying its full costs, they have less incentive to manage or reduce their risk than if they assume all of it themselves. Owners of rental properties frequently report that they can't afford to retrofit their structures without passing on the costs to renters. However, they say they are not able to raise rents because rents are driven by the marketplace.

If we think of risk management in terms of who pays the costs of mitigation and who benefits from mitigation, we quickly see that the current situation has building owners paying almost all the costs, while the benefits are distributed much more widely. It is beneficial to taxpayers and society generally to have fewer lives lost and less disruption after earthquakes, just as it is beneficial to communities to have businesses remain in operation.

The optimum policy and practice would be to align the decisions to manage risk with the benefits derived. In other words, the costs of mitigation should be borne by all of those who will benefit. Government or other institutions may need to intervene and offer incentives to those that make risk decisions in a manner that will optimize social welfare. Incentives or regulatory mechanisms that would more evenly distribute costs may help motivate owners to take action (see further discussion of the issues of costs and benefits on pages 50–55 and 56–61, respectively).

Lack of information can be an impediment to taking action to improve a building's performance. Imperfect information or false assumptions (the earthquake



■ *Using risk analysis, Hughes Space and Communications Company identified one of its El Segundo, California, buildings as a facility that could have operations severely interrupted following a major earthquake. Alternative solutions were evaluated. While strengthening the 1963 reinforced concrete frame structure with shear walls or frame enhancement was an obvious solution, installation would have greatly affected existing operations. Base isolation was chosen because it would allow the continuity of work within the building during construction, and because it would moderate the effects of future earthquake motions on delicate building contents.*

(Photo and text: Hughes Space and Communications Co. and Morley Construction Company)

will never happen here, at least while I own the building; the government will bail me out) contribute to owners discounting earthquake risks when making economic decisions.

How lack of information can influence a risk management decision is seen in most building owners' ignorance of code requirements. First, they may not understand that building to the current code provides only life-safety protection in earthquakes (that is, the building will not collapse and kill people, but it could be a total economic loss). In some cases it is necessary to rehabilitate a building simply to bring it up to life-safety standards, but it still may be a total economic loss after earthquakes. This is not an encouragement to spend a significant amount of money on an upgrade. Owners are often surprised to discover that to maintain the building's function immediately after an earthquake, they must do much more than the code requires, and this is an expensive prospect, particularly for an existing building.

As a tool to help in the understanding of risk and vulnerability, loss estimation modeling has grown into an important subfield. These models help decision makers understand their exposure to an earthquake and the consequences for their businesses, organizations, and communities. Recent advances in software and computer technology have enabled these models to improve dramatically the sophistication and management of large data sets. Models are available to help individual building owners, businesses such as insurance companies, and governments all understand their potential losses and some of their consequences.

■ *"Seismic issues are definitely an important consideration for us when we make a loan or an equity investment in real estate. We have an established set of standards which properties must comply with in order to be acceptable. The standards include both life safety/collapse and PML/economic loss. The collapse criteria relate to current UBC code forces regardless of when the property was built, and the PML threshold is 20 percent. If a property does not comply, we require a retrofit or we do not do the deal. We are usually successful in having a retrofit implemented."*

Major Lender

As the engineering community learns more about how buildings and materials perform under various levels of earthquake demand, individuals will have an opportunity to specify for the engineer what kind of performance they expect from a building. Are they willing to pay the cost to build the structure to a very high performance level to ensure its continued operation after a moderate earthquake? Can they accept that the building may need to be closed for several weeks after a catastrophic earthquake to make repairs? Understanding the level of risk attached to a particular building can be difficult, and deciding if this risk is acceptable may be even more difficult for building owners.

■ *Potential impediments to improved performance, related to risk:*

- Lack of knowledge (not understanding hazard, vulnerability, risk)
- Viability of mitigation
- Uncertainty of the event
- Unacceptable level of financial risk
- Not understanding risk associated with structure
- Not understanding the intent of code requirements
- Allowing development in vulnerable areas
- Differing distribution of risk and decision authority

■ *Conditions that will make improved performance more likely, related to risk:*

- Level of current risk not acceptable
- Possibilities to phase improved performance into existing maintenance schedule (incremental, non-intrusive)

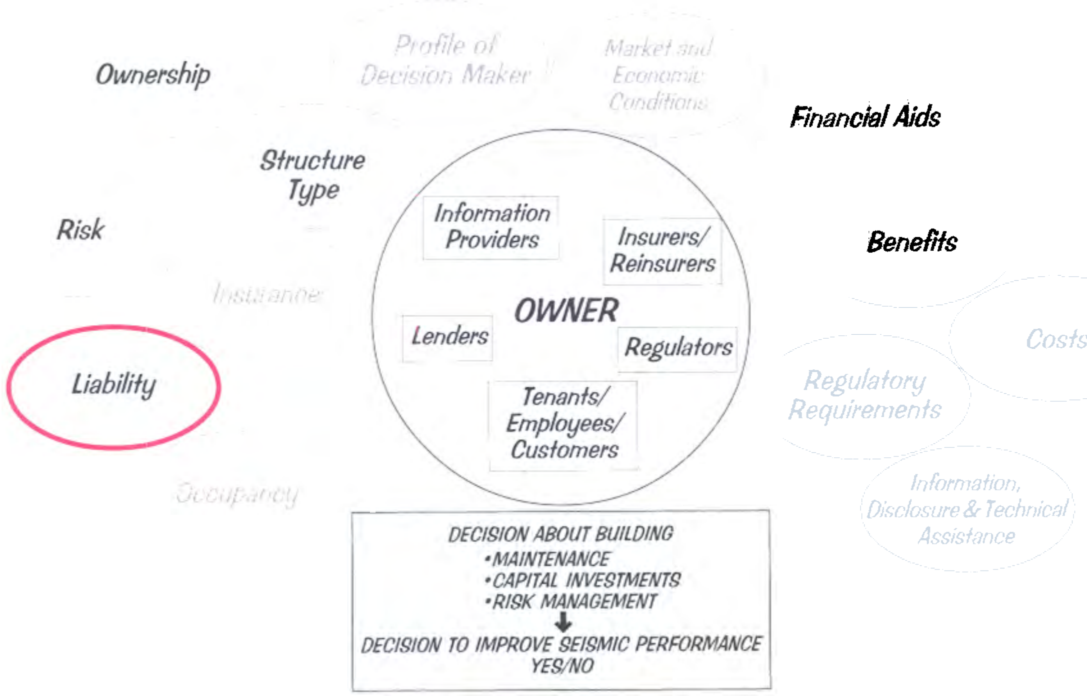


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *After the Loma Prieta earthquake, the Berkeley, California, school district commissioned a study of the expected performance of its buildings in an earthquake. In response to parental pressure, the district worked with seismic experts to evaluate the parameters of its seismic risk. The initial study revealed serious deficiencies in several schools, including its newest. The school board had to take further action, given its legal responsibility to provide safe buildings and since the information had been disclosed in public meetings. The vulnerable schools were closed, students were moved to safer buildings, and local, state, and federal monies were found to fund the retrofit of all the at-risk schools.*

LIABILITY

Potential liability can motivate a decision to strengthen a building. The recognition of legal culpability for unsafe buildings has evolved over the last decade. A 1984 study by the Association of Bay Area Governments (ABAG) found that "the primary motivation for developing earthquake preparedness and general safety programs was never liability as perceived by company officials interviewed. Liability was viewed as having a small but insignificant impact" (ABAG 1984, 25).

The study also surveyed design professionals and company officials in several California cities about their support for, and reaction to, possible changes in liability rules:

> If, by statute, design professionals were explicitly declared liable for their

■ *A church owns a building that is leased to a child care facility. This building is considered seismically vulnerable, based on a preliminary evaluation. Church officials have discussed this situation with their tenant, but neither organization has funds for strengthening. Who is liable should the building fail in an earthquake?*

failure, negligent or intentional, to advise a client to take actions to reduce hazards, three-fourths of those surveyed felt that they would do more to reduce hazards than they are doing now. Similarly, seven-eighths of the company officials surveyed believed that if companies were declared liable for their failure to take such actions, they would do more. . . . More than two-fifths of the company officials surveyed felt that making companies more liable than now would be an effective action to reduce earthquake hazards. Close to two-thirds personally favored increased liability for companies as a means to encourage them to reduce risks from earthquake hazards, if only in some instances (ABAG 1984, 47).

The fear of liability has been responsible in a few cases for an owner taking no action. Some owners fear that knowing about the risk creates a liability that will force them into action that they may not be ready to take or can't afford. Building owners have been advised to have building evaluations in the form of written reports to attorneys who can then exercise client/attorney privilege and not disclose the information further.

There are also those who believe that an earthquake—because it is a natural, unpredictable and awe-inspiring event—is an "act of God" for which no liability should be imposed. In fact, the "act of God" defense is not appropriate to a natural catastrophe if it is reasonably foreseeable and for which reasonable precautions can be taken. In any earthquake-prone area, the reasonable building owner must assume that a major earthquake will strike at or near his/her/its building while he/she/it owns that building. Mass media have disseminated information on earthquake hazards, and the technical expertise necessary to evaluate and mitigate some of those hazards is now available (Bay Area Regional Earthquake Preparedness Project 1992, 124).

In 1990, after the Loma Prieta earthquake, the California Seismic Safety Commission (CSSC) convened a workshop to look more closely at some of the issues in disclosing risk and associated potential liability. Their report pointed out that "a building owner, once informed by a qualified design professional or building official that the building had been determined to have the potential for extensive structural and nonstructural earthquake-related damage or to have collapse or falling hazards that represent an appreciable hazard to human life, would be subject to the duty to warn." The report goes on to state:

> Moreover, a building owner cannot claim ignorance of his or her building's hazards. Traditionally, the building owner or occupier (tenant) has a legal duty to make the premises safe or to warn licensees (people who enter property for their own purposes, such as social guests or even passersby) of conditions involving risk of harm that are not obvious to a reasonable person. In addition, the owner or occupier has an even stronger duty to invitees (business guests, customers, employees, delivery persons, or individuals who come on the property to further the use to which the building owner or occupier is putting his or her premises). On their [invitees'] behalf, **the owner or occupier is obligated to seek out dangerous conditions on the property and remove them** [emphasis added] (California Seismic Safety Commission 1992, 20).

Owners and occupiers cannot avoid responsibility by pretending that they are unaware of dangerous conditions that a reasonable person in their situation either would know of or should know of. However, the question of when a building owner has some obligation to undertake an independent inspection of the property has not been resolved, and "will be resolved on a case-by-case basis by the courts" (California Seismic Safety Commission 1992, 21).

Recent U.S. earthquakes have increasingly resulted in a variety of litigation actions. These have included tenants suing owners for failure to provide adequately safe space and for losses resulting from inability to continue to occupy space; owners countersuing tenants for breach of lease agreements; owners suing designers, contractors, and construction materials suppliers for failure to provide a building capable of adequate performance. To date, most such litigation has been settled out of court and, as a result, no major legal precedents have been set with regard to designer, contractor, material supplier, owner, or tenant liability, related to building performance. However, it is clear that significant potential liability exists, particularly for owners who have, or should have had, knowledge that their buildings are likely to perform poorly but who fail to either notify those who could be affected or take action to mitigate the risk.

Potential impediments to improved performance, related to liability

- Unwillingness to assess risk and vulnerability associated with a property because of fear that knowledge creates liability

Conditions that will make improved performance more likely, related to liability

- Personal prospect of loss, including loss of income

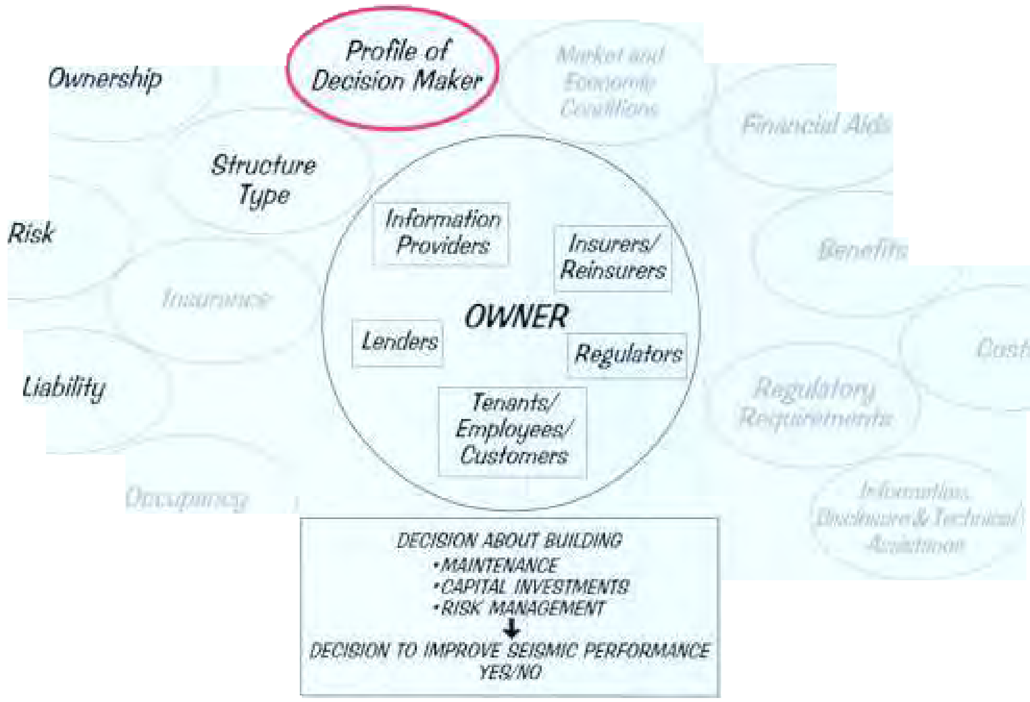


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *The owner of a four-unit wood frame apartment building on soft alluvial soils with tuck-under parking is a widow in her 70s whose husband originally bought the building for an investment. Her grandson helps her with her investment decisions. Several of her tenants have approached her about the seismic safety of the building and she is a little defensive about the questions. Both she and her grandson have lived through several California earthquakes and feel that the so-called experts have exaggerated the risk. She thinks a potential city ordinance that might require strengthening of her type of apartment building is just another way the government has of getting more of her money.*

PROFILE OF THE DECISION MAKER

Will the decision to improve seismic performance be made by a committee, a chain of decision makers, or an individual? If it is an individual, is he or she representing one person or many? Who needs to approve the decision? Who does the owner rely on for advice?

Personal characteristics of the owner influence the decision. How old is the owner or decision maker? What kind of health is he or she in? Age and health have a bearing on how much financial return the owner wants from a building. Is the owner an occupant of the building? Is the decision

■ *Mitchell Earth Sciences Building at Stanford University is a concrete, moment-resisting frame structure designed in 1968, before current requirements for ductility were added to the building code. Buildings of this type are historically vulnerable in large earthquakes, and this structure could have presented a life-safety risk. The geosicence researchers occupying the facility were acutely aware of this risk. As a result, the university considered Mitchell to be one of its highest priorities for retrofit. Proximity to the San Andreas Fault and the need to minimize disruption to the geoscientists occupying the buildings were additional considerations factored into the decision to improve the buildings's expected performance. Due to the expected high cost for retrofit, there were concern that building an entirely new structure might be the most feasible option. The design engineers used new analytical tools (such as those identified in FEMA-273 and ATC-40) to identify the most efficient strengthening scheme (infilling narrow exterior bays). The work was carried out with no disruption to the occupants and for a cost of $1.8 million, $4 million less than the university expected.*

(Photo and text adapted from Degenkolb Engineers 1998)

maker removed from the particular building and possibly the entire geographic region, perhaps a speculator or a trust administrator? Geographic and psychological distance from the building can influence an owner's commitment. Is the decision maker a risk-taker, or risk-averse? How much experience does the owner or decision maker have in building development? Owning an apartment building as a family investment is quite different from acting as a developer, negotiating with lenders, insurers, regulators. What is the financial status of the owner? This can influence the amount of risk the owner might be willing to take as well as the ability to finance the strengthening work.

In many cases, individual building owners are not property developers. They may have inherited one or two buildings, or own the building as a small business, and are not used to dealing with lending institutions and city bureaucracy. Their understanding of the general building and remodeling process may be vague, and to impose on that the special requirements of a seismic rehabilitation project may be even more confusing. More sophisticated owners will have facilities managers or project engineers who can help them through the process.

Previous experience with an earthquake can also greatly influence a decision maker's willingness to consider investing in the improved seismic performance of a building. After an event there is usually a window of opportunity for action. As noted by a planner for the City of San Francisco, describing the passage of their unreinforced masonry building ordinance,

■ *Many seismic safety champions in California share common characteristics. All are articulate leaders, deeply committed to promoting seismic safety within their organizations. All work tirelessly to promote mitigation. All take advantage of earthquakes that occur elsewhere in the world to bring back lessons to their organizations and to try and make the risk more real to their decision makers. Financial constraints have not been insurmountable for any of their organizations, once the will has been created and nurtured to address the problem.*

After the studies were underway, but before any of their information was available, a crucial event occurred. On October 17, 1989, the Loma Prieta earthquake transformed the mindset of San Francisco and central California residents. No longer could earthquake threats be dismissed; earthquakes became real and frightening, and it was clear that they did major damage to structures and killed people (Deutsch 1995, 343).

If a champion for seismic safety comes forward to focus concern on a particular building, class of buildings, or community, it is more likely that action will be taken. This champion may be someone who provides advice to the building owner or community or it may be the building owner himself or herself. If the proponent believes that the earthquake risk needs to be taken seriously and argues forcefully that the owner has an obligation to take action, it can be a significant incentive.

The building owner and his/her/its technical experts together form a construction team; if most members of the team are not knowledgeable about seismic design and construction, it may be difficult for the owner to reach a decision to strengthen a building. How knowledgeable is the architect about seismic safety? Is there a structural engineer on the project who is familiar with seismic issues? How knowledgeable about seismic issues is the contractor? Is that knowledge communicated to the workers on the job? How knowledgeable are city building officials and inspectors?

> ■ *"For new construction projects, building owners rarely make explicit decisions with respect to design criteria. Most owners feel that compliance with prevailing building codes and standards is adequate for their purposes. Few recognize that these are prescriptive standards and, at best, merely imply an unspecified level of seismic performance. Owners rely on design professionals—architects and engineers—and building officials to select, apply, and enforce appropriate design criteria for their projects. A similar situation applies to the retrofit and rehabilitation of buildings. The prescriptive codes in place today normally allow for repairs, additions, or alterations to buildings provided that any new construction conforms to current code requirements. Changes to the building must not diminish its strength or, specifically, its ability to resist seismic forces. Building owners, again, have relied on design professionals and building officials to work out the specifics of these requirements for rehabilitation or retrofit projects."*
>
> (Applied Technology Council and California Seismic Safety Commission 1996, 2–3)

As a steering committee member for this project so aptly noted,

> The understanding of sequential levels of decision making and reporting within an organization is critical to the identification of 'windows' for insertion of relevant information or 'triggers' for precipitating action. Too often we preach to a choir that probably doesn't even vote. Engineering staff often understands and supports mitigation investment but is not able to carry that priority to higher levels in the organization. The message must be delivered in the language of the addressee. And the addressee must have the authority to allocate adequate resources. That authority is placed differently in different organizations. Usually there is a board which reviews a budget prepared by an executive. That executive and that board must be convinced of the wisdom of the mitigation investment. Those folks are not typically structural engineers. We must understand the context of decision making at this level—to understand the competing priorities, the possibility of trade-offs, and the terms of discussion and comparison.
>
> We further must recognize that responding to the rules of this decision process are just as important as responding to gravity in design. Ignoring or contradicting the dynamics of this decision process is just as serious as ignoring the laws of physics in terms of accomplishing the mitigation goal (Krimgold 1998).

Potential impediments to improved performance, related to the decision maker

- Owner not motivated or interested
- Advisors not motivated or interested
- Owner has no experience with building development
- Owner has no experience with earthquakes or other natural disasters

Conditions that will make improved performance more likely, related to the decision maker

- Presence of a champion
- Previous experience of loss from any natural event
- Belief that loss can be personal (affect occupants, employees, etc. as well as have direct economic costs)

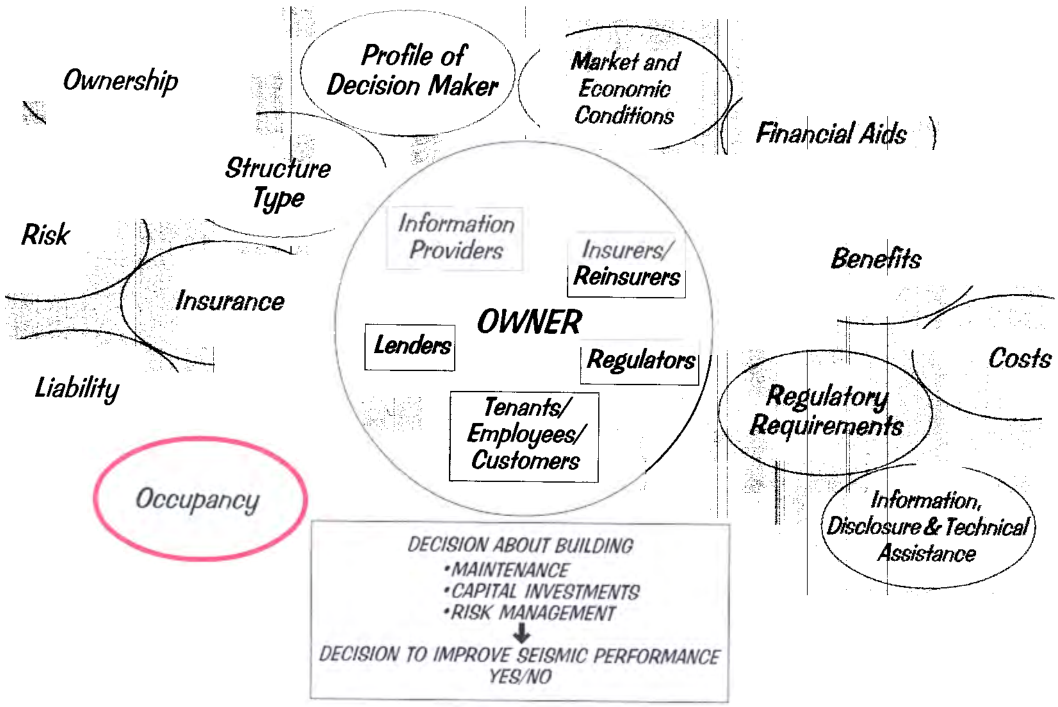


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *In describing the experience of owners and tenants with the Los Angeles Unreinforced Masonry ordinance, Blair-Tyler and Gregory (1990) report that retail tenants stayed in four of the buildings during the seismic work; in one case, the owner reported that business was seriously disrupted during the work. Another stated that the work took twice as long with the tenants remaining in the building. Two building owners removed their tenants temporarily—one for 30 days. In one case, a temporarily displaced tenant returned, but has not been able to reestablish his clientele and is now going out of business. Four of the owners permanently displaced their tenants, in most cases by letting the lease run out before beginning the seismic work. After the work was completed, the space was released to new tenants. No major change in the use of the space occurred during this process, i.e., retail space remained retail space; office space remained office space.*

OCCUPANCY

If a building has a high number of occupants or a particularly vulnerable population, it becomes a higher priority for improved performance. Some buildings are occupied only intermittently, but may have very high populations when they are—theaters, for example. Other buildings may have few occupants during the day, but many at night (apartment buildings). Office buildings can have a high population during the day and none at night. Some buildings house a population that has no choice about being in the building (schools, prisons).

If the building is already vacant, the question of moving tenants is irrelevant, but if the work is going to be conducted with the tenants in place, this may add to the cost of the project or the length of time required

■ *A contractor in Beverly Hills retrofit an 11-story office building and worked out a creative schedule with the manager and the tenants whereby construction workers began their shifts at 10 p.m. and worked until 6 a.m. They sometimes worked both days on weekends, and arranged special hours for work inside a busy restaurant on the ground floor.*

The same contractor devised a creative strategy for the retrofit of a dormitory at the University of California at Los Angeles, where students lived in some of the rooms while work was in progress. Among the steps taken were planning meetings with students and resident advisors, regular progress bulletins, and a barricade-painting contest, with T-shirts then made to carry the winning design. A student move between wings of the dorm was orchestrated over one weekend, accompanied by a barbecue. The construction workers were invited to a party celebrating the end of the project.

to complete the work. Retrofit work that requires the displacement of tenants—resulting both in the loss of income and potential cost for relocation—is very unattractive to owners. To reduce the impact of rehabilitation work on low-income housing residents in particular, some jurisdictions have required that relocation costs for each unit be paid by the owner. These ancillary costs add to the total cost of the strengthening and are an impediment, sometimes killing the project.

Tenants may also play a role by pressuring an owner to take some action. Tenants may require upgrading of a building as a condition to signing a lease In some cases, what an owner does may not be well-received by the tenants. Owners may choose to vacate the building, and/or find a new location for the tenants.

With the Los Angeles URM ordinance, most building owners and managers were not able to increase rents to recoup the expenses of seismic strengthening. When a building was leased after the work was completed, market rates were asked. Further constraining rate increases were long-term leases, with rates locked in (Blair-Tyler and Gregory 1990).

Potential impediments to improved performance, related to occupancy

- Displacement of existing tenants
- Relocation costs
- Disruption of occupants and functions

Conditions that will make improved performance more likely, related to occupancy

- Building currently vacant
- Occupants support risk reduction
- Occupants want to avoid earthquake losses
- Flexible construction schedule

The Hotel Utah

Located in Salt Lake City, this 10-story historic structure was constructed in the early 1900s. Now owned by the Church of Latter Day Saints, the owner wanted to convert the guest room floors into offices and maintain the historic interior spaces of the hotel such as the lobby, original ballroom, and reception rooms. Seismic upgrade was not required by any governmental agency as part of this major remodel, but was desired by the owner to provide an increased level of life safety to the occupants of the building and reduce property damage during an earthquake. The original facade of the building could only have minor alterations in keeping with the wishes of historic preservation organizations. The hotel was closed so maintaining occupancy was not a consideration in the design of the upgrade and remodel. Feasibility studies indicated that new concrete shear walls would provide the most economical method of upgrade.

The seismic upgrade of the building has now been completed and the building is back in use. Most of the building is used as office space by the owner, but the historic areas of the building, as well as the top floor, are open to the general public. The top floor houses two restaurants and reception rooms. The seismic upgrade of the building was completed for a cost of approximately $4.5 million, according to the contractor's post-construction estimate, or approximately $9.90 per square foot. This cost does not include the costs to demolish and replace existing finishes since these finishes were removed and replaced as part of the remodel of the building.

Miller and Reaveley 1996

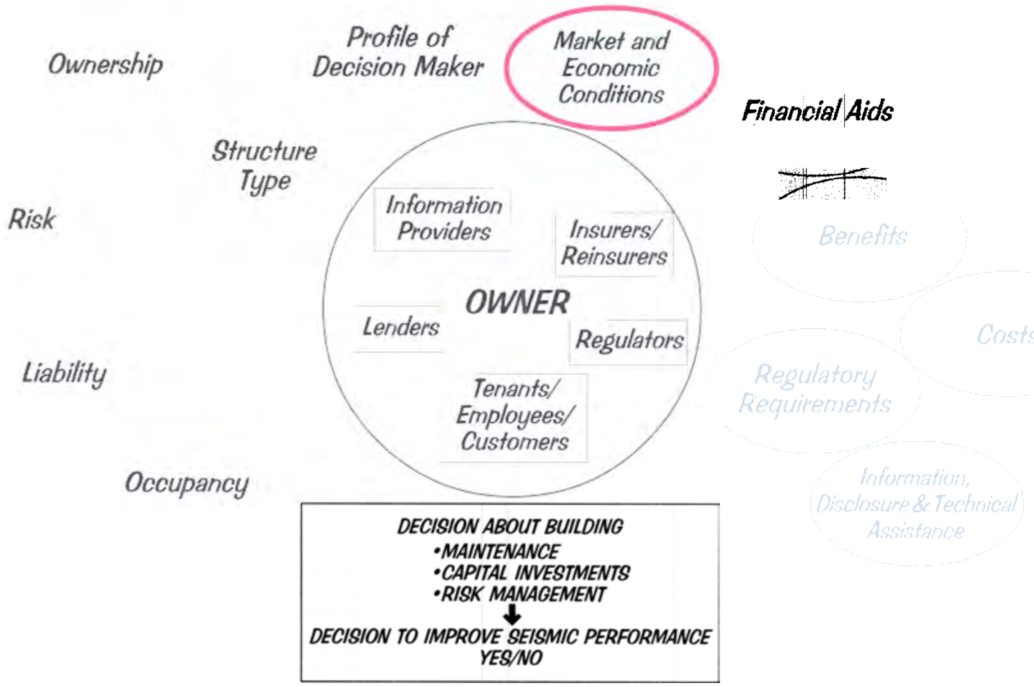


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *A San Francisco-based developer is developing a new, 450,000-square-foot, 24-story, commercial office building in the city's South of Market district. The building is competing in the tenant market with several other new commercial developments. In order to market the new space successfully, the developer decided to promote the building as a state-of-the-art development with advanced mechanical and electrical features to support the growing shift to an electronic work place. The building's seismic reliability also plays a significant role in the marketing strategy. The developer intends to market the building as having a low probability of long-term interruption of occupancy due to earthquakes. In support of this objective, a project-specific structural design criterion was developed, with strict limits on earthquake induced inter-story drifts.*

MARKET AND ECONOMIC CONDITIONS

Market and economic conditions will influence the decision to improve seismic performance.

- Is the real estate market booming, with many transactions, or is it slow? A slow or static market makes it less likely that an owner will invest money in retrofit since the owner will not be sure he or she can regain the money at the time of sale.
- How strong is the market for the product or service provided by the owner? Can enough product or service be sold to cover the debt for the retrofit?
- What is the debt capacity of the building? Is it currently mortgaged to capacity or can it carry additional debt?
- What is the expected business or economic interruption in the event of an

■ *"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 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."

(Building Seismic Safety Council 1997, 7)

■ ***"The buyers in a seismically active area such as San Francisco are very aware of seismic upgrade issues, particularly associated with unreinforced masonry buildings. They will not pay the same price for an unreinforced building that they would pay for a strengthened building of the same caliber."***

California lender

earthquake? Can the business afford to be closed for a lengthy period? If the answer is no, this can be a major incentive for retrofit.

Despite what has been claimed or believed in the past, there is growing evidence that the real estate and financial markets increasingly reflect a demand for buildings that are seismically strengthened. In California some government officials believe that the property ownership market (as opposed to rentals) reflects an increased value for upgraded buildings. Although it is still rare to find mention in a real estate advertisement of a building's expected performance in an earthquake or additional upgrading, the cost of retrofit is reflected in the sales of unreinforced masonry buildings in most of coastal California.

Some banks and lending institutions routinely require an analysis of expected seismic performance when making loans, but not all. Nor do insurers routinely ask about expected seismic performance when selling earthquake insurance policies. However, one Oregon insurer stated that his firm routinely advises customers on what they can do to reduce their risk, including when they are building a new residential or commercial building.

Lenders play a key role in an owner's risk management decision since most buildings are heavily mortgaged. As part of a loan application, the lender may require a report on probable maximum loss (PML). If the PML exceeds 20 percent, the lender usually requires the owner to strengthen the building or to purchase insurance. If the PML is less than 20 percent, the lender typically

■ *"Some buyers look at it as an opportunity to do the upgrades and improve the value of their asset."*
California contractor

■ *"The key question is whether the market will operate to stimulate rehabilitation. When you buy a house, you have to get a termite inspection, maybe bracing for the water heater, but not a seismic evaluation. If mortgage lenders don't recognize the risk, why should the home buyers?"*
California architect

■ *A major property owner on the West Coast was planning significant renovations to one of its buildings. The building was vacant in preparation for the renovation. A seismic analysis was conducted of the building, indicating some problems but nothing that made the PML unacceptable. The owner decided that a seismic retrofit might drive down the market for the building because there would be visible signs of retrofit, and the building would no longer be considered Class A. A very desirable tenant expressed interest in the building and conducted their own seismic analysis. Their analysis indicated some seismic problems with the building, enough that the prospective tenant became hesitant about leasing space there. The tenant was so valuable to the owner that the owner was willing to conduct the seismic strengthening work, at a cost exceeding $1 million. In this case the market created value for the seismic retrofit, through a knowledgeable tenant and a willing owner.*

■ *"Companies that are paying attention to seismic safety considerations tend to be those that own their buildings and are staying for a long time."*
California structural engineer

assumes the risk. Currently, different techniques are used in preparing PML reports, making them less valuable as risk management tools than if a standard definition and methodology could be used throughout the industry.

Developers and corporations that buy buildings for investments hold a property for a few years at most. It makes more sense for them to pass the seismic risk onto future owners than to invest in mitigation themselves. In a recent study of owners of unreinforced masonry buildings in Los Angeles, several owners noted that strengthening does not increase a building's equity and, therefore, the costs must be viewed as an operating expense, rather than an investment. When the building is viewed as a short-term business investment, rehabilitation or building above code is not a part of the investment equation. The length of time investors hold onto properties may be changing as more and more buildings are owned by publicly traded REITs (Real Estate Investment Trusts). REITs are publicly held, so their holdings don't turn over as much; they are buying properties for longer periods of time.

Using the market place to create value for seismic safety has been suggested as a strong motivator for improving the performance of buildings. If strategies could be developed or nurtured that create this value, the market place might end up taking care of many of the bad buildings in our communities.

Recent work by May et al. on how to improve rates of residential retrofit suggests that markets must be created for third-party services such as home inspection and reha-

The electric utility company which serves eastern Missouri has its headquarters and general office building in St. Louis, Missouri. The original complex consists of two buildings, one a steel frame, and the other a reinforced concrete frame. A new addition was added in 1988 which greatly increased the size of the complex. The new addition was designed to the then-current seismic code. During the planning phase for the new building, the existing buildings were evaluated for seismic resistance. At that time, it was determined that the existing concrete building was vulnerable to design level earthquake ground motions.

The concrete building contains the utility's main power distribution center, which monitors the usage of electric power throughout the system, as well as administrative offices. The utility deemed the building an essential facility which would be vital for the post-earthquake recovery from any seismic event that affected eastern Missouri. Thus the goal of the seismic strengthening was to be fully operational after an earthquake.

Several strengthening schemes were evaluated to meet the owner's goals and budget. The final retrofit design consisted of reinforced concrete shear walls added around the perimeter of the building and at selected interior column lines.

(Photo and text: EQE Thiess, St. Louis)

bilitation. One element in creating such markets is the provision of information to homeowners. The authors argue for the creation of a standardized building rating system that provides a clear indication of the earthquake risk for a given home and the cost-effectiveness of different mitigation measures. They also argue that the certification of firms involved in testing and mitigating different harms would be required in order to create this market, as would available financial incentives and financing for homeowners (May et al. 1998).

To date, lenders and insurers have contributed to a situation in which the risk from earthquakes is not distributed or managed equitably in the marketplace. The government now bears a significant portion of the risk (by paying for response—rescue and clean-up—and many recovery costs, and through lost property, sales, and income tax). Ironically, governments may also have compounded the problem by allowing individuals to make choices that significantly increase this risk and decline the purchase of insurance protection. The result is a much higher level of risk of financial losses and mortgage defaults than might otherwise be the case (Klein 1998). In fact, a recent study reported that in the Northridge earthquake, according to estimates, after foreclosure expenses, property repair costs, lost income from interest, write-downs of loan balances, and additional administrative costs, mortgage-related losses totaled $200 to $400 million (Shah and Rosenbaum 1996).

"Going into new deals there is always pressure to avoid any issue which could impede the business transaction from occurring, but when a property is foreclosed on or purchased, and we become the owner, we incur all the risks. And when selling, many buyers are aware of seismic issues, and the better the seismic resistance of the property, the better the selling price."

Major Lender

Potential impediments to improved performance, related to market and economic conditions

- Sluggish economy
- No debt capacity of building
- No market demand for seismic improved performance
- Short length of time building held by one owner
- Weak real estate market and rental market

Conditions that will make improved performance more likely, related to market and economic conditions

- Creating value for improved seismic performance in the market place
- Booming economy
- Requirement for improved performance on the part of the lender or insurer
- Ability of the building to carry additional debt
- Ability of sales of product or service to cover the cost of improved performance
- Strong real estate and rental market

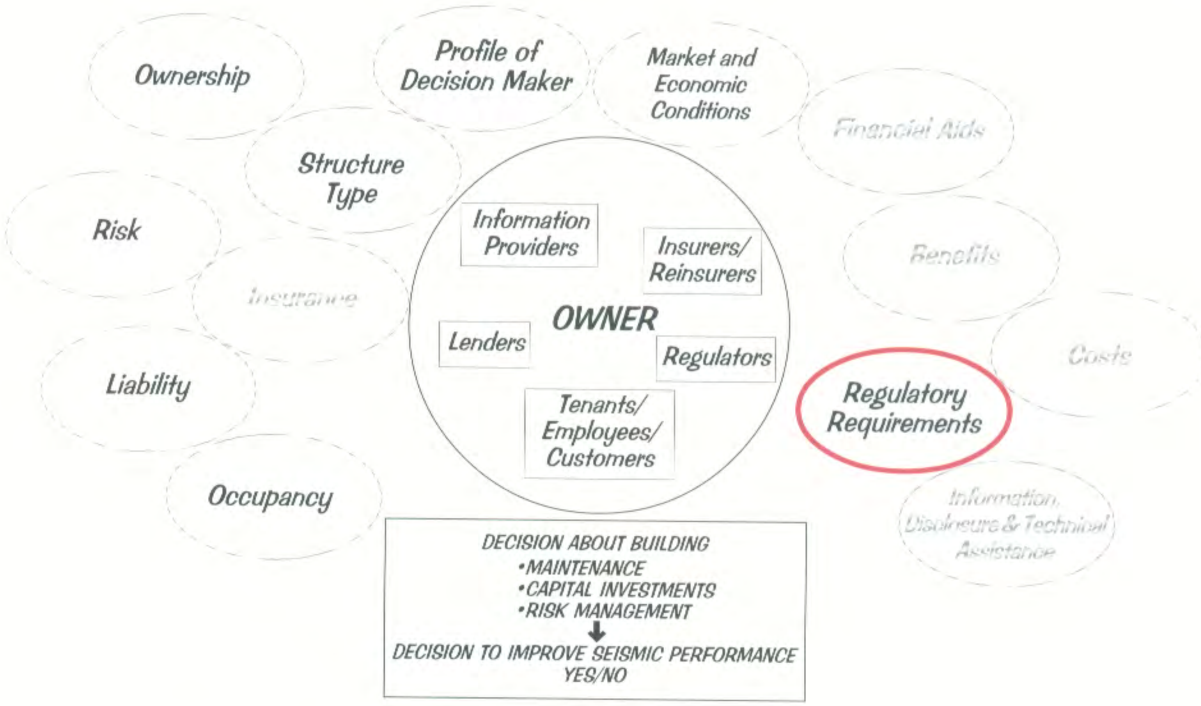


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *Outgrowing the existing facility, the leadership of a California synagogue recently decided to buy a building and move to a new location. The remodeling triggered accessibility and other mandated upgrades, including seismic strengthening. The bill for remodeling jumped from an original estimate of $600,000 to $1 million, requiring further fund-raising on the part of the already cash-strapped congregation. Over $450,000 has been spent to meet various code requirements. On the positive side, however, the congregation increased the safety and accessibility of the building significantly.*

REGULATORY REQUIREMENTS

Government requirements, regulatory constraints, and regulatory relief (such as fee waivers) are all part of the context for the decision to improve seismic performance, and can act as important incentives or impediments to improving seismic performance of buildings. There are a number of other programs that require building owners to take action, but they are not actually incentives. For example, in California the state has a number of mandates for improved seismic performance of certain building uses or locations. The Field Act and the Hospital Act require public schools and hospitals to meet stringent design and construction requirements and construction quality control procedures. The Alquist-Priolo Earthquake Fault Zoning Act requires the state geologist

■ *A member of the coalition to create a retrofit ordinance for unreinforced masonry buildings in Oakland had this to say about requirements and compliance "The city officials wanted some level of public safety that they . . . could hang their hats on. Liability issues [arose] and it was a very slow process to drag them into considering the lower option and what incentives there might be to get people to go to a higher option. The eventual ordinance was a voluntary one with a mandatory retrofit at only a very low level."*

(Olson et al., 1998, 37)

to map areas of potential surface rupture along active earthquake faults. Location within these and other known seismic hazard zones must be disclosed at the time of sale of buildings in these zones.

Constraints

Many California jurisdictions as well as jurisdictions in other states have triggers for the improved performance of buildings. The San Francisco building code, for example, has provisions that trigger seismic upgrade of existing buildings whenever substantial alterations, major repairs, or occupancy changes occur. In practicality this ordinance applies primarily to commercial structures. In Seattle, Washington, a similar trigger in the code exists, specifying that if a renovation is deemed a substantial alteration, the seismic provisions of the current building code or an approved standard are enforced.

The cost of improving seismic performance can become unacceptably high because the work often triggers other requirements, particularly compliance with disability access and other code requirements such as fire sprinklers and hazardous materials, including lead and asbestos. This is often cited by owners as one of the most important impediments to taking action (Russell 1997). In fact, according to a San Francisco building official, up to 20 percent of the cost of the building rehabilitation is typically spent for disabled access (Kornfield 1998).

To reduce this burden, some jurisdictions have tried to impose only minimal additional requirements. The City of San Francisco conforms to a state attorney general's decision that, for unreinforced masonry

■ *Based on the experience of several California jurisdictions, officials have noted that, despite the small dollar amounts of some of the incentives, if the incentives are just big enough to get owners to complete a seismic design, owners are much more likely to move ahead and complete the retrofit construction.*

Retrofit detail on unreinforced masonry building. (Photo: California Governor's Office of Emergency Services, Coastal Region)

building upgrades, the city must enforce Title 24 for disabled access. To address the issue of code requirements for seismic rehabilitation, San Francisco joined with the Structural Engineers Association of Northern California to create a blue-ribbon panel to rewrite its seismic code provisions. The city intends to modify its code requirements to encourage partial voluntary seismic upgrades. This may be a powerful incentive, which should be followed carefully to determine its effect in promoting voluntary seismic rehabilitation.

Other cities are considering ways to reduce the triggers for other code-complying work. The City Council in Salinas, California, is considering options to relax the ordinance requiring improved performance of unreinforced masonry buildings since it triggers compliance with federal Americans with Disabilities Act requirements (CSSC 1997). In Portland, Oregon, seismic upgrades are exempt from the state fire-safety, energy, and access requirements, but nothing can exempt a building from the federal Americans with Disabilities Act (National Academy of Public Administration 1997).

Incentives

Regulatory relief can act as an important incentive to improved performance. Table 1 identifies a wide range of incentives being used by California jurisdictions to ensure compliance with either mandatory or voluntary programs to strengthen unreinforced masonry buildings. According to the California Seismic Safety Commission evaluation, economic incentives seem to encourage owners in voluntary strengthening programs to retrofit (CSSC 1997).

TABLE 1

CALIFORNIA JURISDICTIONS WITH INCENTIVE PROGRAMS TO HELP WITH THE COMPLIANCE OF LAWS REQUIRING THE IDENTIFICATION AND/OR STRENGTHENING OF UNREINFORCED MASONRY BUILDINGS

(Source: California Seismic Safety Commission 1997)

JURISDICTION	#URMs	INCENTIVES
Arroyo Grande	25 nonhistoric	Flexible with its deadline for compliance, reduced permit fees, extended time limits, and non-conforming building use permitted
Berkeley	587 nonhistoric	Imposes ½% transfer tax on property sales with proceeds used to retrofit the structure , waives permit fees, posts clearly visible warnings
Escondido	50 historic 7 nonhistoric	Mills Act (property tax reduction for owners of historic properties) and fee waivers
Fullerton	43 historic 82 nonhistoric	Grant and deferred loan program
Grover Beach	4 nonhistoric	Building for building replacement allowed without having to meet parking requirements
Hemet	3 historic 9 nonhistoric	City paid for engineering and plans
Inglewood	56 nonhistoric	City reimburses up to $3000 of the cost of engineering studies, 100% of plan check fees, permits and taxes using redevelopment money
La Verne	10 nonhistoric	Offers up to 50% grant to cover engineering and construction costs
Los Gatos	6 historic 15 nonhistoric	Revocation of occupancy for buildings that do not comply with deadline, replacement of damaged buildings without providing more parking
Palo Alto	4 historic 43 nonhistoric	Increased occupant density allowed, additions to strengthened buildings allowed, parking requirements waived
Pomona	96 nonhistoric	Ordinance tied to special assessment district or similar financing
Rancho Cucamonga	18 historic 4 nonhistoric	Pamphlet developed explaining various options and incentives, encouraging use of Mills Act

JURISDICTION	#URMs	INCENTIVES
San Francisco	516 historic 1551 nonhistoric	Bonds to fund seismic retrofit loan program
San Diego	NA	Voluntarily reviewed the URM situation in the community, appointed City Manager's Committee on seismic retrofit, requires property owners to retrofit structure when it changes use or increases occupancy
San Jose	74 historic 72 nonhistoric	Redevelopment fund grants for engineering design work, exempts permit fees, forming special assessment district to provide bond financing, developed tenant assistance program
San Leandro	1 historic 39 nonhistoric	Assessment district to fund low-interest loan program
San Mateo	28 nonhistoric	Grants and loans
Santa Barbara	80 historic 183 nonhistoric	Seminars for contractors and building inspectors
Santa Clara	24 nonhistoric	3% interest loans to fund engineering analysis with a 5-year payback
Torrance	50 nonhistoric	City funded subsidy to pay for the engineering analysis at $0.50 per square foot, and formed $679,000 assessment district for those who chose to join
Tustin	8 nonhistoric	Community development block grants for up to $2000 provided for engineering costs
Upland	58 nonhistoric	$2 million commercial rehabilitation loan program—loans at market rate, architectural, engineering and loan packaging
Vacaville	14 historic 7 nonhistoric	3% redevelopment matching loan program over 25 years for retrofits. Façade loans.
Vallejo	8 historic 56 nonhistoric	$40,000 per building maximum CDBG loan
West Hollywood	20 historic 81 nonhistoric	Amended the rent control program to allow rent increases, $7100 per building Community Development Block Grant funds, housing rehabilitation program of $10,000 per building, reduction or waiver of fees, zoning incentives

Some of the zoning controls mentioned in Table 1 can be used as incentives to improve seismic performance of buildings. The following discussion is summarized from *Seismic Retrofit Incentive Programs: A Handbook for Local Governments* (Bay Area Regional Earthquake Preparedness Project 1992, 76–78).

Density/Intensity Bonuses

A city can offer specific increases in the maximum allowable building density to help offset the added costs of seismic upgrades. For example, a number of communities allow taller or larger buildings if pedestrian amenities are provided, or if parking is placed underground.

Transfer of Development Rights (TDR)

A city can allow a property owner to transfer unused development rights to another site, based on the rationale that there is a public purpose to be achieved in requiring a seismic upgrade, and the existing use of the building may not generate sufficient income to justify the retrofitting costs. TDR is particularly suited to designated or certified historic structures where no intensification of use is contemplated or even allowed. The value of the development right to be transferred should approximate the cost of the retrofitting.

Reduction in Development Standards

The objective of allowing for a minor reduction in certain specified building or site development standards would be to offset the added costs associated with retrofitting older structures.

Relief from Nonconforming Provisions

Many older seismically hazardous buildings may not conform to the development standards that now apply to new construction. For example, there may not be any on-site parking and the setbacks may be less than currently required. Some exemptions for seismic upgrade can be made for alterations or enlargements of these structures.

Restrictions on New Occupancy

A zoning ordinance could require that any applicant for a discretionary zoning permit for occupancy of a URM or other potentially hazardous building that does not conform to current building code standards for seismic safety present a schedule for upgrading the structure to meet seismic standards within a stated period of time.

Real Estate Offices

In California, the state government and the state institutions of higher learning strongly prefer to lease buildings that are in compliance with the building code and other strengthening regulations that might apply. For example, the state Real Estate Services Division has a Seismic Safety Lease Renewal Policy that requires a building assessment (using FEMA-310 or other current method) before a long-term lease on a private building can be renewed. Such polices serve as incentives for building owners who want to rent their buildings to public agencies.

Federal Executive Orders

Two potentially very important executive orders have been promulgated related to seismic safety. One applies to new federal building construction and one applies to existing federal buildings. The potential effect of these orders, in particular the one

> *"The U.S. Department of Interior currently has underway a risk analysis to identify its extremely high risk buildings, along with the rehabilitation cost estimates, as required by Executive Order 12941. The department has placed a high priority on addressing deferred maintenance issues, and/or issues affecting the health and safety of employees and the public. Interior has framed the new priority in the FY2000 budget guidance by requesting a 5-year plan from each bureau to address, as a priority, critical health and safety deferred maintenance issues. This will include the rehabilitation of high risk buildings identified in the EO 12941 efforts. Designs on the highest risk buildings will be initiated in FY1999. A specific funding plan is in place that will allow funds to be directed to the buildings with the greatest need."*
>
> John Baals, Department of Interior
> Seismic Safety Coordinator

related to existing buildings, is as yet unknown. As the second order becomes more widely applied, its potential effectiveness in encouraging improved performance and rehabilitation will become more apparent.

Executive Order 12699 of January 5, 1990—Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction
Each federal agency responsible for the design and construction of each new federal building is required to make sure that the building is designed and constructed in accordance with appropriate seismic design and construction standards. This order applies to the lease of new buildings, as well as buildings where the federal agency is assisting in the financing, through federal grants or loans, guaranteeing the financing, or through loan and mortgage programs. In addition, each federal agency with generic responsibility for regulating the structural safety of buildings should use appropriate seismic design and construction standards for new buildings within that agency's purview.

All federal agencies have reported that they have adopted at least one of the model codes recommended by the Interagency Committee on Seismic Safety in Construction. Up-to-date seismic design practices, as embodied in the current model codes, are now recognized as significant aspects of all federal new building construction projects (FEMA 1997c).

Executive Order 12941 of December 1, 1994—Seismic Safety of Existing Federally Owned or Leased Buildings

This order requires the president to adopt, "standards for assessing and enhancing the seismic safety of existing buildings constructed for or leased by the Federal government which were designed and constructed without adequate seismic design and construction standards." The standards developed, issued, and maintained by the Interagency Committee on Seismic Safety in Construction (ICSSC) have been adopted as the minimum level acceptable. The adopted standards specify five triggers that mandate a seismic evaluation of a federally owned building; however, these triggers are apparently generating very few actual rehabilitations.

In addition to the standards, this Executive Order requires that agencies inventory their buildings and come up with an estimate of how many are at risk and how much it would cost to fix them. Armed with this information, which is due on December 1, 1998, FEMA will develop a proposal to Congress, due December 1, 2000, containing a systematic, economically feasible plan for achieving adequate seismic safety in existing federally owned buildings. The process of developing the inventory has been a great awareness-builder in the agencies (Todd 1998).

Potential impediments to improved performance, related to regulatory requirements

- Triggering other work
- Lack of retrofit standards
- Inconsistent levels of code enforcement

Conditions that will make improved performance more likely, related to regulatory requirements

- Government policies prohibiting the leasing of buildings that fail to meet earthquake standards
- Government policies requiring newly owned or assisted (using public funds) buildings be seismically resistant

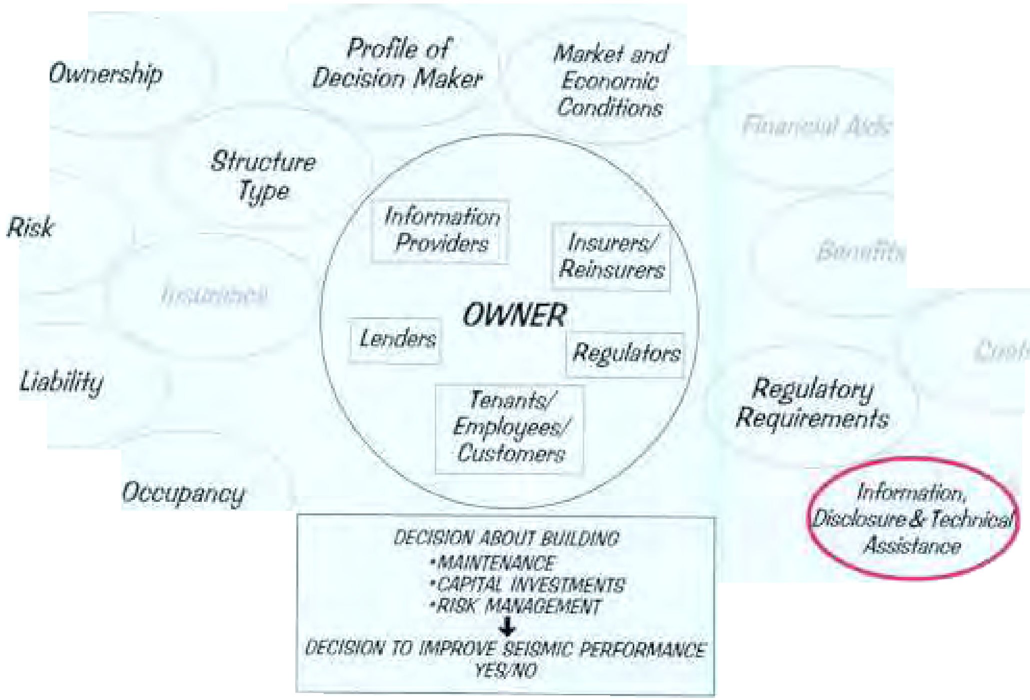


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

INFORMATION, DISCLOSURE, TECHNICAL ASSISTANCE

There are various government and private sector programs that provide information or technical assistance, or require the disclosure of risk. We have ample empirical and anecdotal evidence that information is a necessary first condition for a decision maker. It may not bring about a decision to mitigate, but without it, no such decision is even possible.

City of Palo Alto: Disclosing Risk

The City of Palo Alto adopted an ordinance that requires owners of all pre-1973 construction to perform seismic safety evaluations of their buildings and record the result of the study along with the deed for the property. The owners must notify tenants of the study and inform the city of how they intend to mitigate any hazards the study reveals. Although this is public information, other occupants, such as employees or customers of tenants, do not receive notice of the hazards. The ordinance also includes incentives allowing increased occupant density and relief from parking restrictions for seismically retrofitted buildings. It has apparently spurred quite a few property owners to retrofit their buildings. Part of the reason, no doubt, is that they cannot transfer the deed without the seismic safety issue coming up on a title report, which may cause some adjustment in the purchase price (California Seismic Safety Commission 1992).

City of San Leandro, California: Technical Assistance

Part of a $300,000 earthquake preparedness appropriation (which includes federal hazard mitigation grant funds) assists residents with the improved performance of their homes. The Home Earthquake Strengthening Program contains four basic elements: a set of publications to assist the homeowner in getting underway with a retrofit; a separate inspection and permit for this type of work; a tool-lending "library" for those residents doing the work themselves; and community training for retrofit construction. The *Homeowner's Handbook* was developed to show how to strengthen wood frame homes and was delivered to all single-family residences in the city.

A more detailed publication, the *Prescriptive Standard and Plan Set*, was prepared as a set of numbered construction details for strengthening wood frame homes, and offers a standard scope of work for contractor bids as well. Both publications are available to homeowners at no cost. The city offers a pre-construction inspection specifically for the earthquake strengthening work. Permit fees are set at low rates to minimize the number of households avoiding the work because of costs. A series of five two-hour construction workshops is offered by the city to those homeowners who want to do bolting and bracing on their own. A one-day course, Contractor Seismic Safety Training, is required for contractors who wish to be included on the list of qualified contractors available to homeowners in the city (ABAG 1998).

Oregon Seismic Rehabilitation Task Force

A Seismic Rehabilitation Task Force was created in Oregon in 1995 to address a series of issues related to the rehabilitation of existing buildings. The task force, consisting of representation from all the major stakeholder groups interested in seismic safety, recommended retrofit of unreinforced masonry buildings in Oregon within 30 years of adoption of the proposed measures; rehabilitation of other buildings within 70 years; the completion of a statewide inventory by 2004; a mandatory strengthening program for essential facilities; rehabilitation of other buildings through a set of passive triggers; and the creation of incentives, including a tax credit and a property tax abatement (Seismic Rehabilitation Task Force 1996). Although the legislation required to implement these recommendations has not been enacted, this task force played an important part in building awareness and providing information that can be used as the basis for future policy making.

California Seismic Safety Commission

Legislation in the state of California requires disclosure of known seismic vulnerabilities to prospective buyers. Realtors are required to give a copy of the *Homeowner's Guide to Earthquake Safety*, developed by the California Seismic Safety Commission, to prospective buyers at the earliest possible time before sales. Owners are required to fill out an evaluation form on the seismic safety of the house. The guide is the largest selling earthquake publication in California, with roughly 300,000 sold since 1992. A similar publication exists for commercial properties.

■ *By providing technical assistance, the Earthquake Program of California OES has played a role in stimulating some building owners to take action. OES staff played a significant role in helping Berkeley Unified School District decide to address the seismic problem with their buildings, by providing encouragement, technical reports, and access to other state agencies. As noted in an OES publication, "that hazard mitigation gets done within a context much larger than the schools themselves has been demonstrated in the Berkeley, California, school district in recent years. Developments in the Berkeley Unified School District after the 1989 Loma Prieta earthquake were fairly typical of the steps involved in earthquake preparedness planning and hazard mitigation in any school. However, it is significant that in Berkeley all the typical obstacles have been overcome. Berkeley's preparedness and mitigation plans were adopted and implemented for a number of reasons: concerned and informed people, natural events, resource organizations, technical reports, state mandates, available money, circumstances and committed personalities (not necessarily in that order)."*

(Photo and text adaped from California Governor's Office of Emergency Services 1993)

California Law Requiring Placarding Buildings

In California, state law requires that unreinforced masonry building property owners in Seismic Zone 4 must post a sign with the following suggested language:

This is an
unreinforced
masonry building.

Unreinforced masonry
buildings may be unsafe
in the event of a
major earthquake.

The sign must be in a conspicuous place at the entrance of the building. One of the chief building officials in San Francisco thinks the signs are good in the sense that they let people know they are facing a risk when entering one of these buildings. However, he admits that in most cases people choose to ignore the signs because they have no choice. The requirement for posting this information is not widely enforced.

California OES Earthquake Program

California OES, with 50 percent support from NEHRP/FEMA funds, has a program to develop publications and disseminate them to various types of building owners and governments throughout the state. These publications provide information on how to prepare for an earthquake, including information on how buildings can be seismically strengthened. (See in particular *Strengthening and Repairing your Wood Frame House*, California Governor's Office of Emergency Services Earthquake Program 1995.) Evaluation of the usefulness of these materials in motivating action has been spotty,

■ *"Information is essential to convince leaders and planners that they need to deal with seismic and other risks. Packaging information is also critical."*

Oregon planner

although a 1990 survey found that 80 percent of the people receiving the materials found them to provide the type of information they needed (Michaels 1990). Since it is information, but not regulation, there is no enforcement and little evaluation.

FEMA Technical Assistance Programs

FEMA has funded a series of publications over the last decade addressing various technical, as well as social and economic issues, in earthquake risk reduction. A number of these have proven to be important documents in the advancement of earthquake engineering, including the identification of hazardous buildings and the selection of appropriate mitigation strategies. More recently FEMA has underwritten the development of guidelines for rehabilitating existing buildings.

Many engineers and city officials have cited these FEMA technical publications as important influences in their understanding of seismic issues. As discussed above, institutional owners often use the FEMA methodologies in their building evaluations, and these evaluations frequently form the basis for a retrofit decision.

■ *A facilities manager for an institutional owner began visiting earthquakes on his own after he took his job. In his words, these visits became the most important on-the-job training in his career. Over time, his employer encouraged and subsidized such visits, recognizing the valuable information he was able to bring back. Now when there are earthquake-related articles, the owner sends the facility manager short notes—"Are we doing enough?"—relying on the manager's judgement and knowledge to keep the institution on track with its strengthening program.*

Learning from Earthquakes

Site visits to earthquake-damaged areas are a great learning experience. Upon return, many field observers convey a sense of reality and urgency to co-workers and decision makers in their organizations. These experiences allow them to speak knowledgeably and credibly about the specific consequences of earthquakes. Engineers are able to convey this information to their clients—owners

■ The University of California at Berkeley began an evaluation of the expected performance of its buildings in the mid-60s, based on prodding by staff and faculty aware of the proximity to a major fault. Over the next thirty years more detailed evaluations were conducted of some of the most vulnerable structures, and some of these most vulnerable structures were either taken out of use, had their use changed, or were seismically strengthened. Since the 1970s, the campus has spent more than $250 million in state money on seismic improvements. Sufficient funding to conduct all the seismic strengthening needed has always been a challenge. In the fall of 1997, the university released a list identifying 57 buildings as unsafe, with a price tag for the needed repair work of at least $700 million. Fifty more buildings, mostly off-campus, were added to this list in the spring of 1998, developed under the second phase of the two-part review, and increasing the estimated costs for repair. The university currently has a backlog of deferred maintenance estimated at $200 million. The university has launched a program called Seismic Action Plan for Facilities Enhancement and Renewal (SAFER) that will ultimately bring all campus buildings up to a minimal level of life safety. A new high-level position has been created to oversee this challenge. FEMA has approved funding for engineering firms to design a retrofit for Tolman Hall to test new building codes and structural design strategies. Plans are also underway for Wurster Hall and Hearst Mining Building, among other buildings.

(Text adapted from Sanders 1998)

and institutional decision makers who can use the information directly in their organizations.

The Earthquake Engineering Research Institute runs a Learning From Earthquakes program with funding from the National Science Foundation. EERI sends reconnaissance teams to earthquake sites. The lessons observed are transmitted to the professional community via technical briefings, slide sets, videos, and publications. EERI is also a major participant in the Post-Earthquake Information Clearinghouse, a collaborative effort of a number of California organizations to gather and make useable immediate post-earthquake observations.

Learning from Peers and Professional Associations

Professional associations and peers also play an important role in providing information that may ultimately lead to the strengthening of a building. In the FEMA-sponsored study, *Financial Incentives for Seismic Rehabilitation of Hazardous Buildings,* the authors recommended targeting the American Hospital Association, the Public Risk and Insurance Management Association, the Risk and Insurance Management Society, Inc., state municipal leagues, and the national associations which serve the lenders (banking, thrift, appraisal) as a means to get out information regarding improved performance (Building Technology Inc. 1990a).

In interviews conducted as part of a recent National Academy of Public Administration project on improving seismic safety in existing federal buildings, many participants mentioned professional associations, such as structural engineers associations, as valuable sources of technical information (NAPA 1997). EERI has technical briefings for its members and distributes much information to them.

■ *Potential impediments to improved performance, related to information and technical assistance*

- Lack of information
- Lack of retrofit standards

■ *Conditions that will make improved performance more likely, related to information and technical assistance*

- Opportunities for learning from earthquakes
- Availability of technical assistance and information
- Disclosure of risk

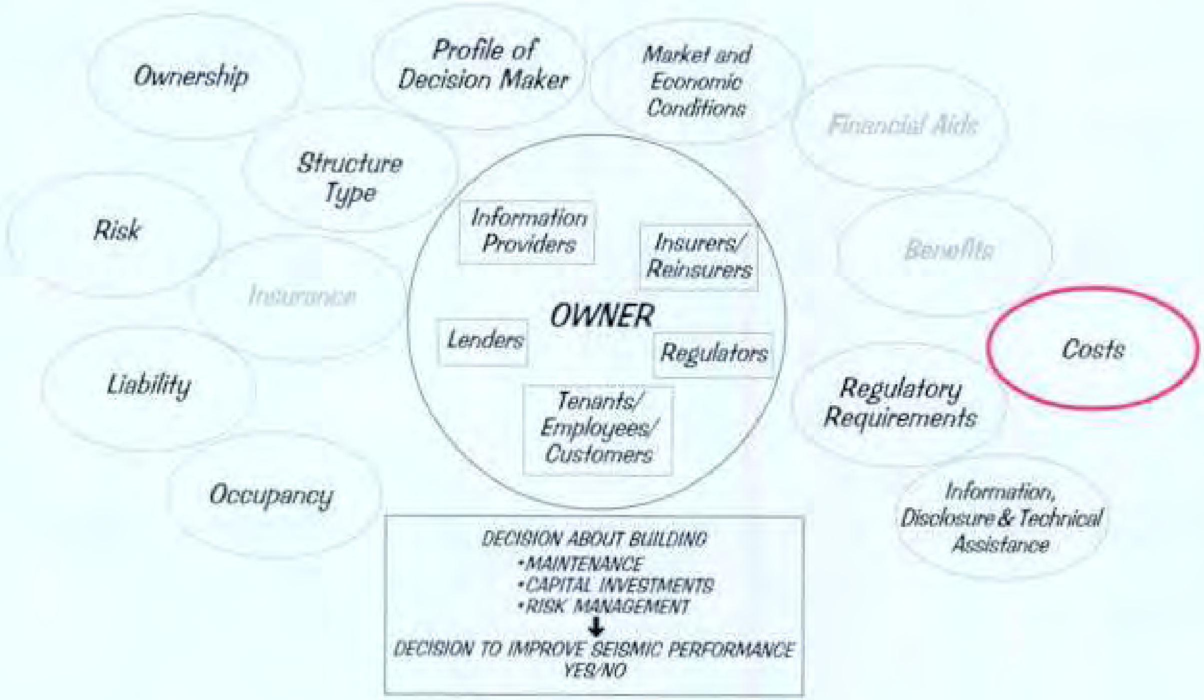


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

> ■ *"After having strengthened four buildings, the owner vowed he would not do another. He believes that costs cannot be recouped for work on low-income buildings, and that the contractors are the only ones making any money. The only good thing about the process is that the building will not be reassessed for property taxes as a result of the work."*
>
> (Blair-Tyler and Gregory 1990, 83)

COSTS

Improving the seismic performance of a building can be expensive, and usually the work is not visible upon completion. Costs vary widely, making it difficult to identify "typical" costs. This variation is dependent on a number of factors, including the location, the type of structure, the characteristics of the individual building and the rehabilitation scheme, the level of performance desired, and other work done at the same time. Even different wings within one building can have widely differing costs for improving expected seismic performance, depending on the problems associated with each wing.

■ *"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, and others."*

(Building Seismic Safety Council 1997, 21)

Direct Costs

In the FEMA report, *Typical Costs for Seismic Rehabilitation of Buildings (Second Edition)*, the authors identify direct rehabilitation cost components.

Construction costs include:

- structural rehabilitation costs (cost for structural work performed by the contractor and the subcontractor)
- nonstructural rehabilitation costs (includes cladding, parapets, architectural and mechanical/electrical/plumbing systems, and equipment necessary for the building to function as intended)
- demolition and restoration costs (architectural work necessitated by the structural work)
- cost to repair existing elements used as part of the lateral force-resisting system

Non-seismic-related construction costs include:

- fire and life safety (the building or fire department may require an owner to upgrade fire protection and other life-safety provisions, including improving the fire rating of certain walls, providing sprinklers and fire escapes)
- mechanical, plumbing, and electrical renovation (owner may be required by building or fire department to upgrade these systems, or owner may take the opportunity to undertake these upgrades)
- architectural renovation (owner often takes opportunity to make architectural renovations and improvements beyond architectural demolition)
- damage repair costs (cost to repair structural damage from previous earthquakes, settlement, or deterioration in elements

■ *In a recent FEMA report on Costs and Benefits of Natural Hazard Mitigation, Caltrans discusses its costs for retrofitting vs. replacement. Officials state that the typical cost per square foot for retrofitting is $32, while the typical cost for a replacement bridge is $135. Thus the average bridge retrofit is about 22.7 percent of replacement cost. These results do not even take into account the significant indirect benefits of retrofitting that accrue to the residents of the earthquake area in terms of reduced traffic congestion and delays.*

(FEMA, March 1997b)

of the building not affecting the seismic performance of the building)

- hazardous material removal costs (cost to remove hazardous materials such as asbestos, lead paint, or contaminated soil)
- costs to provide access for the disabled (cost to provide improved accessibility to disabled individuals as required by federal, state and local laws)

Nonconstruction costs include:

- management costs (costs necessary to manage the project, performing analyses, obtaining financing, negotiating with design consultants, testing laboratories, contractors, city officials, tenants, and clients)
- design fees, testing and permitting costs (cost of design professionals, testing and inspection firms, building permit fees)
- relocation costs (cost to relocate occupants and equipment due to the disruption expected by the construction; often this cost can be one of the largest)

(Hart and Srinivasan 1994)

The same report identifies a number of factors that can influence the rehabilitation costs, including

- seismicity
- performance objectives
- structural system
- occupancy class
- building area
- number of stories
- building age characteristics
- occupancy condition

It can be difficult to recover costs since seismic retrofit has not in the past been generally perceived as creating market value for a property, either by increasing property

■ *"Building owners should think of their buildings as renewable resources. Earthquakes occur within a geologic time frame, giving owners who carefully manage their resources the time to develop strategies to improve the performance of their buildings."*

California engineer

values or by somehow making a property more desirable. A critical factor in the decision to improve seismic performance is the owner's determination of the likelihood that costs can be recovered (through increased rents or at time of sale) in an acceptable period of time.

Indirect Costs

There may also be indirect costs in terms of lost square footage or space needed for the structural elements that may need to be added. In a study of building owners and the unreinforced masonry ordinance in Los Angeles, Blair-Tyler and Gregory found that this was a major indirect cost for at least one owner (1990).

Opportunity Costs

There are also opportunity costs with seismic strengthening. Every dollar spent on improving the performance of a building is a dollar that is not spent on something else. What will not be done because the money will be used for improved performance? A school district, for example, may not be able to begin construction for a new building because what money there is has to be used to improve the seismic performance of existing buildings. Forfeiting or postponing construction of a new school is not the first thing the school district usually wants to do.

Experience suggests that an important strategy for managing the costs of improved seismic performance is to build as much as possible into the ongoing facilities management program. For example, at the time of routine building maintenance, remodeling, reroofing, or change of occupancy, basic seismic upgrading can occur.

Working together as a construction team may also help reduce rehabilitation costs. The architect, contractor, and engineer can discuss and evaluate cost-cutting ideas together and make modifications as a team. If the project is not being put out to bid, but will be handed to a selected design and construction team, it is possible that very elaborate plans and specifications will not be as necessary.

■ ***Potential impediments to improved performance, related to cost***

- High costs
- Difficulty in recovering costs
- Indirect and lost opportunity costs
- Unavailability of financing

■ ***Conditions that will make improved performance more likely, related to cost***

- Possibility of rolling costs into larger upgrade
- Financial assistance
- Minimization of future disruption

Bradbury Building

The Bradbury Building, built in 1893, is a five-story steel fame building with a brick and sandstone exterior. The exquisite interior has an inner court with perimeter offices topped with a glass skylight. The interior is enhanced by open cage elevators, beautiful wood paneling, and ornamental grill work and balcony railings imported from France. The building has been used as a setting for several movie and television productions. Truly an architectural landmark, the building was designated an historic monument by the Cultural Heritage Board of the City of Los Angeles.

The notice to comply with Division 88 came in 1983. The owners decided to proceed with the seismic work, coupled with a complete renovation of the building's interior. The owners claim they made the decision to proceed based on an estimate of $800,000–$900,000 for the seismic work alone. The work ended up costing about $2.4 million without the interior renovation.

Because of its unique design, the building has attracted tenants for the office space. Before the seismic work began in 1983, the building was 90 percent leased with retail on the ground floor and professional offices on the upper floors. The upper floor leases were terminated soon after the seismic work began and the space remained empty, generating no income throughout the work. The building was pre-leased during the interior renovation which began after the seismic work was completed in 1988. Interior renovation is expected to cost an additional $1 to $3 million.

The building was one of the first to be started and everyone's lack of experience coupled with the unusual design of the building created problems. Because of the building's design with its five-story open interior topped by a glass ceiling, it was not possible to close off or remove the upper floors. The only options were complete strengthening or complete demolition.

Work on the Bradbury Building was partly financed through a $800,000 low-interest loan from CRA (Community Redevelopment Authority). CRA also negotiated the sale of the building's air rights for $1,100,000. The owners also took the permitted 20 percent historic rehabilitation tax credit. The rest of the cost was financed with a bank loan. Even with this substantial public assistance, the owners claim that rents would have to be raised by $1.50 to $2.00 per square foot to pay for the work. In retrospect, they say that if they had known at the start how much time the work would take and how much it would cost, they would have pushed for partial demolition or closed off the upper floors.

(Photo and text: Blair-Tyler and Gregory 1990, 58–59)

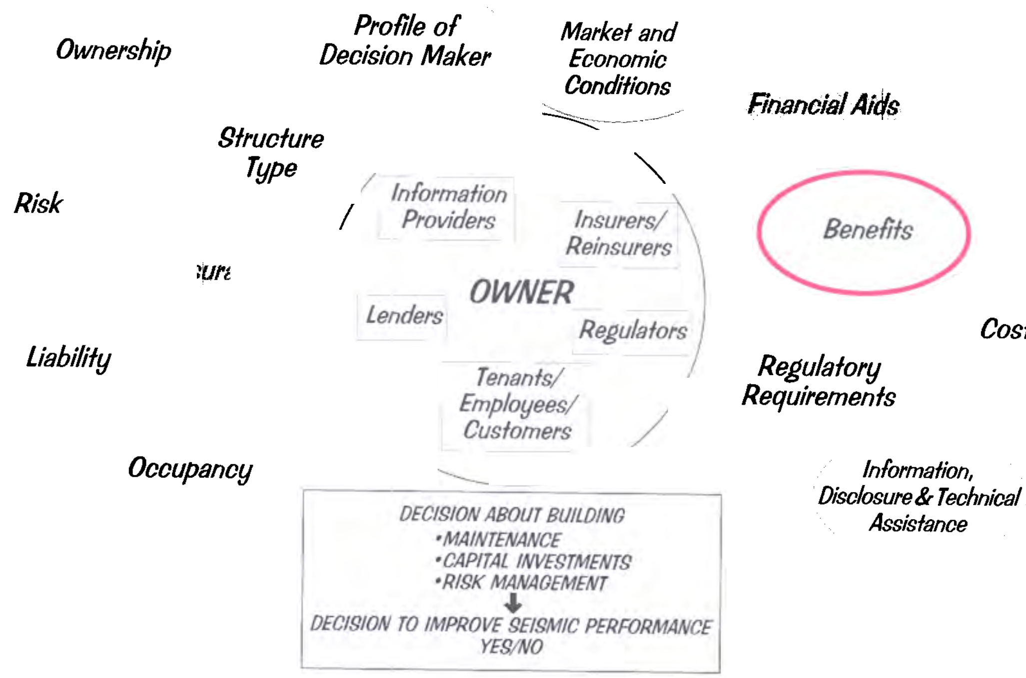


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

BENEFITS

There are important benefits from improving the seismic performance of a building: protection of life, property, and possessions, as well as continuity of business. The major difficulty in evaluating and appreciating these benefits is that most accrue in the future, at the time of an earthquake. The costs of improving the seismic performance of a building are current, and the improvements may never be tested. Another serious issue has to do with who gets the benefits. All these bones of contention are summed up in the observation below:

> Local adoption of seismic mitigation policy is difficult politically because it often places additional economic or regulatory burdens on particular groups, such as building owners and land developers, and because the benefits, in the form of reductions in loss of life and property, are uncertain and occur in the future. Moreover, though the costs associated with mitigation programs are generally specific and obvious, their benefits are more diffuse and do not attach to particular people (Beatley and Berke 1990, 63).

The costs for improved seismic performance are immediate; the benefits are measured in terms of future building performance in an uncertain event. Table 2 below identifies considerations in thinking about costs and benefits, and illustrates the difficulty in making comparisons between today's costs and tomorrow's benefits.

■ *The rehabilitation work performed at the Price Club store in Richmond, California, in 1986 is a good example of earthquake upgrading of concrete tilt-up buildings. Constructed in 1963, this building was found to need strengthening by the structural engineer responsible for a renovation. Although the upgrade was not required by code, the owner recognized the vulnerability of the structure and felt that seismic upgrading was appropriate to protect customers and to minimize economic loss after an earthquake. The seismic strengthening work was done as a separate element of the remodeling necessary to convert the warehouse for use as a retail outlet. Because the building was not occupied during strengthening, there was no disruption to building occupants. Most of the work was completed within ten weeks. The total projected seismic retrofit cost, not including the design fees, was $350,000 (1986 dollars), or approximately one dollar per square foot. Approximately 20 percent of the construction cost was related to anchorage and continuity measures, 40 percent was associated with new bracing and 40 percent was for new foundations.*

(Photo and text adapted from Bay Area Regional Earthquake Preparedness Project 1989)

TABLE 2

Costs and Benefits of Improved Seismic Performance

COSTS TODAY	PASSED ON TO WHOM
Cost of mitigation	Next buyer (higher purchase price) Lender (decreased owner equity) Tenant (disruption of use, rent) Taxpayers (if subsidized) Insurers (if rate/reduction in premiums)
FUTURE BENEFITS (if/when earthquake occurs)	**PASSED ON TO WHOM**
Loss reduction	Owner/lender
Life safety	Occupants/public
Content loss reduction	Occupants
Business loss reduction	Occupants
Societal disruption reduction	Community
Relief reduction	Taxpayer
Insurance claim reduction	Insurance community

(developed by Fred Krimgold 1998)

Financial Benefits

In his keynote address to the 1997 EERI Annual Meeting, a California engineer illustrated how an owner might determine whether the costs of improving the performance of a building are economically justifiable (Hamburger 1997). He assumed a 100,000-square-foot structure with a replacement value of $100/square foot, and he assumed seismicity such that there is a one in 200 probability of a major earthquake at the site at any time. Most people would not find a 1 in 200 chance of an earthquake very compelling. And, if an owner discounts benefits based on the uncertainty associated

■ *"One industry that has a heightened awareness of earthquake risk is the high-tech industry, especially the computer industry. Computer-related products can be very costly and the daily economic output of high-tech businesses can far exceed the cost of the structure that houses them. We were hired by a computer company to evaluate two tilt-up buildings that they lease. They use the buildings to assemble and store expensive computer products. Our evaluation resulted in recommendations for retrofit to reduce the PML and provide a life-safe condition for the building's occupants in a significant local earthquake. The evaluation and retrofit were done voluntarily. The company intends to discuss their findings with the owners and, hopefully, negotiate shared responsibility for the proposed seismic upgrade."*

California engineer

with an earthquake's occurrence, the costs most likely outweigh the benefits.

However, using a deterministic assumption (that is, assuming the earthquake will actually occur, rather than discounting projected losses based on the probability of the event's occurrence), he did calculations for an earthquake in the 5th year of ownership, the 10th year, and the 20th year (Table 3).

He took the present value of a loss in some future year and subtracted the present value of the residual loss if the building is upgraded before the earthquake. This indicates how much money an owner should be willing to spend on upgrade today to avoid a known expense in the future. His analysis shows that if an owner believes an earthquake will occur during his ownership of a building, he will be economically motivated to upgrade, or alternatively, to purchase insurance.

TABLE 3

Assumptions:

Building Value	$10,000,000
Deterministic Earthquake	5th, 10th, 20th year
Probable Loss	50% of value
Residual loss (after retrofit)	10% of value
Cost of Money	5% per year

Break-even Cost for Retrofit

Year of Earthquake	Present Value of Loss
5	$33/sq ft
10	$26/sq ft
20	$20/sq ft

■ *Top management of Rockwell International Corporation wanted uninterrupted operational capability at its corporate headquarters, even if a magnitude 7.0 earthquake should occur on the Newport-Inglewood Fault, passing less than a mile from the building. Rockwell decided with the aid of expert consultants to upgrade seismically existing Building 80. This option saved both time and money, when compared to the building of a new structure. The upgrading took place over 14 months, while the building remained fully occupied around-the-clock by 600 employees.*

(Photo and text: Morley Construction Company)

In short, someone who goes by statistical probabilities would not find the benefit-cost relationship attractive. But someone risk-averse, who believes an earthquake could occur during ownership of the building, would find the costs worthwhile.

Other Benefits

While some decisions about how to manage the risk for a particular building are made strictly by weighing potential loss (physical damage) against potential cost of the improved performance (as illustrated in Table 3), many other decision makers factor in important intangibles. In the private sector, such intangibles include protecting lives, business continuity, maintaining a competitive position, and public image. In the public sector, such intangibles include protecting health and welfare, preserving a certain building stock (historic buildings, for example), preserving certain building uses (such as low-income housing), reducing the need for displacement and demolition, as well as the ability to provid uninterrupted services. The uncertainty associated with an earthquake may be outweighed by the complete unacceptability of the possibility of losing equipment, or production capacity, or certain buildings. Thus, the benefits that will accrue in the future may be much more substantial than the costs that are incurred today.

Observable Benefits

In California there have been enough recent earthquakes to demonstrate that the benefits of improved performance have outweighed costs. A reconnaissance report after the Northridge earthquake evaluated the performance of many buildings, including a number that had been previously retrofitted

■ *Starbucks made a commitment to lease up to four large floors of warehouse space in Seattle, Washington, and convert it to the company's corporate headquarters. The change in occupancy from warehouse to corporate office space caused the project to qualify as a substantial alteration. The City of Seattle in such a case enforces the seismic provisions of the current building code or an approved standard. Currently the city accepts FEMA–178 as an approved standard. The seismic performance objective of this standard is life safety. The retrofit scheme that was developed for this building added lateral strength and ductility to the building while providing sufficient drift-control. The contractor was engaged in the design phase, an important consideration in resolving many constructability issues related to installing 1,000 tons of steel in a fully occupied building. The building contained numerous tenants, all of whom needed to remain fully operational during construction. For this reason, all work in the year-long construction phase was completed at night. This project was the largest seismic upgrade in Seattle to date, and required a team effort by engineers, architects, owners, contractors, tenants, and building officials.*

(Photo and text adapted from Lundeen and Fretz 1998)

(Holmes and Somers 1996). Three tilt-up buildings in the area of strong ground shaking constructed prior to 1976 code changes, but retrofitted, sustained minor or at most nonhazardous damage. In contrast to these buildings, four nonretrofit, pre-1976 buildings suffered significant damage. There was no evidence of wall anchorage, subdiaphragm continuity ties (cross ties), and confinement ties at girder support on top of pilasters in any of these buildings. In one, two wall panels moved out of place as much as six to eight inches. These excessive deformations caused water damage from joint separation of sprinkler pipes and suspended ceiling system failure in an office area (Holmes and Somers 1996, 108). Wood frame buildings that had strengthened cripple walls showed the effectiveness of such improved performance.

Because of a 1981 ordinance requiring seismic strengthening of unreinforced masonry (URM) buildings in Los Angeles, there are data on the performance of retrofit and unretrofit URM buildings. The great majority of retrofit URM buildings survived the earthquake with minimal or no damage, and there were no deaths or injuries in a URM building. As would be expected, unretrofit URM buildings performed worse than both reinforced masonry buildings and retrofit URM buildings. Many suffered significant structural damage and posed a serious risk to life safety (Holmes and Somers 1996).

Wood frame building with strengthened cripple walls. (Photo: James Russell)

However, while the performance of retrofit URM buildings was consistent with what engineers and city officials expected (reduction of risk of death or injury), this was not the expected performance as understood by some owners. Many owners did not realize that a retrofit building can be substantially damaged, occasionally to the point of not being economically repairable. In addition, owners evidently did not have a full appreciation of the expected variability of damage due to site location, configuration, and quality of design and construction (Holmes and Somers 1996). It is important that owners clearly understand the extent to which the seismic performance of their buildings will be improved before investing.

Potential impediments to improved performance, related to benefits

- Perception that costs exceed benefits
- Limited definition of benefits (excluding intangibles)
- Difficulty in measuring future benefits deriving from an uncertain event

Conditions that will make improved performance more likely, related to benefits

- Perception that benefits are greater than costs
- Overriding factors that compel owners to retrofit even if benefits can't be readily quantified, such as protecting lives, business continuity, maintaining competitive position, public image

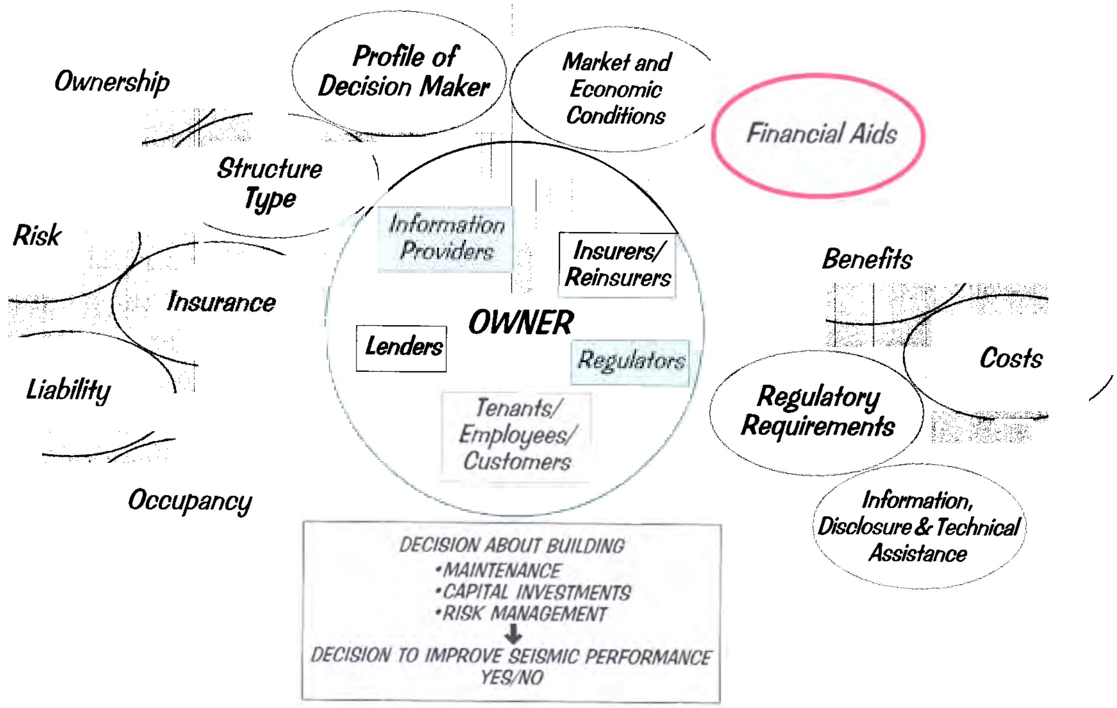


Figure 1 THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

■ *A Southern California city developed a program for the seismic retrofit of downtown commercial buildings (one- and two-story). The retrofit, mandated by local ordinance, was accepted by the downtown business community when it was partnered with preferential rate financing. This financing was offered through two major banking organizations. The redevelopment agency staff packaged all loans for submission to the lenders and assisted property owners through the entire design, permit, and construction process. All loan requests submitted were approved by the lenders. The first group of 35 buildings was funded at $15 million in eleven months. The entire area, initially 90 percent vacant with occupied space rented at $0.11 sq. ft/month, became a thriving commercial downtown area, where present vacancy rates are below 10 percent and where the average rent is $0.90 sq. ft/month.*

FINANCIAL AIDS

Financial incentives can be one of the most important elements in the decision to strengthen a building. Past experience suggests that there are several:

- Tax policy, including tax credits for seismic retrofit work, tax deductibility for the work, and tax abatement so that seismic retrofit work does not contribute to an increased property tax
- Grants, reduced interest loans, loan guarantees, and subsidies for retrofit work

A number of financial incentive programs have been developed over the past decade at the federal, state, and local governmental levels to encourage building owners to strengthen buildings. There is a general sense that these programs are not sufficient,

■ *The Crescent Arms Apartments is an 11-story building in Los Angeles. In its 1920s prime, the office building contained a theater for live performances and auditions, and a dance studio with inlaid hardwood floors. Standing empty in the 1990s, the developers wanted to convert the building to meet the housing needs of a neighborhood in transition. The owners, the design team, and the contractors worked over several years to refine the details and the budget. Significant public funds were used in the project. Substantial mechanical and structural upgrades were made building-wide, as it changed from office to residential use.*

(Photo and text: Morley Construction)

and have not yet resulted in a significant increase of upgraded buildings.

Some of the programs are also contradicted or undercut by other programs. For example, tax policy allows building owners to deduct losses from a natural disaster, but not the expense of mitigating to reduce such losses. The availability of disaster assistance programs has created the mistaken impression that the federal government will bail out building owners after a disaster. Unfortunately, the perception that the federal government will make an owner whole again keeps many owners from investing a penny in improved seismic performance.

Federal and state laws related to taxation and bonding capacity can act both as impediments and incentives. Current bonding limitations and tax laws such as the 1986 Federal Tax Simplification law are major impediments. This tax act established a policy of simpler tax forms and discouraged states from adding new lines on tax forms for special tax credits or deductions. As a result, income-tax related tax incentives, if any, will most likely originate in Congress rather than in state governments. After the Loma Prieta earthquake the California Seismic Safety Commission introduced an act, which was signed into law, that allows cities to use general obligation bonds for private building retrofits. This acts as an incentive.

To make financial incentive programs effective, one has to identify objectives and expected results and evaluate a program's ability to meet the objectives. For example, how many property owners will be motivated to take action by a five percent tax rebate? How many buy a loan one or two

■ *"We were hired by the owner of a tilt-up warehouse to provide an evaluation and probable maximum loss (PML) of their building. The owner was in the process of refinancing the property and the lender required the seismic study. Our evaluation indicated that the tilt-up was vulnerable to partial or full collapse of the roof in a sizeable local earthquake. The lending institution stipulated that retrofit would be required to bring the PML down to an acceptable range. In the lending business this level typically corresponds to the deductible on earthquake insurance policies. We provided details of a retrofit scheme to reduce the PML. The owner hired a contractor to do the work and we confirmed that the installation of new roof to wall anchors was in conformance with our recommendations."*

California engineer

percentage points below the going rate? If the financial incentive is not sufficient in itself, are there other elements of a program that could be developed that, when combined, are sufficient to motivate owners?

Bank Lending

[This section is adapted from Bay Area Regional Earthquake Preparedness Project, *Seismic Retrofit Incentive Programs: A Handbook for Local Governments* 1992.]

Faced with a project which needs financing, most owners turn to their local bank. In the case of retrofit projects, the banks are often less than eager to lend. Obvious concerns are credit issues, such as loan-to-value ratios, and debt service coverage (the ratio of funds available to make payments to the principal and interest payments themselves). In a bank's view, retrofit projects are particularly difficult unless the owners have built up enough equity to support the additional loan.

For the most part, the banks look at the owner's cash flow and ability to repay the loan; the value of the collateral is a secondary issue, as the bank wants never to have to collect on it. Further, the value of the collateral is, in the bank's eyes, not its cost but its market value. The market value of the property, and thus the bank's collateral, will not necessarily be improved by a retrofit project.

One might argue that the banks should be concerned with their potential for loss in the event of an earthquake. However, it appears that large banks in particular consider it reasonable to take the risk associated with hazardous buildings in their loan portfolio, planning to write off in the future such losses as are incurred rather than to spend money now to prevent potential losses. Other risks to banks, such as credit card fraud, happen on a daily basis and are therefore more compelling.

New bank lenders, ones not already associated with a property, have an even stricter test of the value of the collateral. Until the seismic retrofit is complete, the banker considers that at any moment the earthquake may happen and the structure collapse. From a collateral perspective, then, unless earthquake insurance is available, the banker can only count on the value of the underlying land, less demolition/clean-up costs, less existing loans. It is a rare property that can withstand this form of analysis, and it is a rare bank which today will make such a loan.

The banker's logic is derived primarily from the perspective taken by bank regulators. Bank regulators painfully scrutinize banks' portfolios, and apply harsh tests to determine their creditworthiness. Regulators apply the logic outlined above to the analysis of banks' portfolios, and require that more capital be set aside in reserve against riskier loans. Riskier loans are therefore more expensive for the banks, which must then choose either to forego them in favor of cheaper loans or to pass the added costs onto the borrower. Adding to the borrower's cost, of course, makes it harder for the borrower to pay, debt service coverage deteriorates, and both bankers and owners find themselves in a frustrating position from which bankers extricate themselves by simply withdrawing from the market.

Government Programs

The following examples show how some governments have constructed financial incentive programs using various sources of funding, and they can be viewed as a starting point for building further programs. The examples cited here are intended to be illustrative rather than exhaustive.

City of Hayward, California—Using Financing from Private Banks

Hayward developed a program to finance structural retrofit affordably, as part of its unreinforced masonry ordinance implementation. The city developed an economic development-based revitalization plan for the older downtown, where most of these buildings are located. The program provided help in keeping tenants and finding new businesses to occupy vacant space. It included architectural help to define financially sound ways of making the buildings look and function better. It provided short-term loans to cover up-front costs of employing engineers, architects, appraisers, and environmental studies. It included rapid plan check procedures and a unique program to assist in upgrading the financial picture for property owners and tenants. The city also financed a loan program through private banks (Clayton et al. 1994).

City of Berkeley, California—Reduced Permit Fees and Transfer Tax Rebate

Berkeley has two financial incentive programs to encourage building owners to strengthen their buildings. First, a local ordinance waives permit fees paid to the city for seismic retrofits of nonstrengthened residences and unreinforced masonry structures.

■ *Hazard mitigation incentive programs work! Berkeley has two programs to encourage property owners to retrofit their homes—the first is a permit fee waiver for all residential seismic upgrades; the second is a transfer tax rebate to home buyers who retrofit their newly purchased house. A recent new buyer learned about the incentives from the real estate agent handling his sale. The realtor cited the programs as an added advantage to purchase in Berkeley. The buyer upgraded his home because "we live in earthquake country," and he didn't feel that inadequate coverage from earthquake insurance was enough to protect his largest personal investment. He learned from a local technical assistance agency that structural engineers recommended exceeding code standards to protect against property loss (and it was what they as professionals did when retrofitting their own homes).*

Second, the city has a 1.5 percent tax levied on property transfer transactions; up to one-third of this amount can be applied to seismic upgrades during the sale of property. Qualifying upgrades include foundation repair or replacement, mudsill repair or replacement, wall bracing in basements, foundation to mudsill bolting, shear wall installation, water heater anchoring, and securing of chimneys. Since 1993 these programs have been applied to about 6,300 houses, representing approximately $4.4 million in foregone revenues to the city (Chakos 1998).

California Property Tax Exclusion

In 1990 California's voters passed Proposition 127, which exempts seismic rehabilitation improvements to buildings from being reassessed to increase property taxes. This law, which is an amendment to the Revenue and Tax Code, has a sunset provision of June 30, 2000.

California Department of Insurance Loan Program

The California Department of Insurance (CDI) and private lending institutions offer a low-interest rate earthquake retrofit program loan to qualified borrowers. The CDI allows selected banks to underwrite and manage loans and guarantees that, as long as the CDI underwriting specifications are complied with, CDI reimburses the lender 100 percent of a covered borrower's defaulted principal balance. The program can be used for single-family through four-plex properties owned by low to moderate income households and can also be used to retrofit mobile homes. The bank charges the property owner one percent above the current prime rate for interest. Maximum loan amounts range

■ *The City of Oakland, California, was one of the initial Project Impact cities. They have developed a program called Project SAFE (Safety and Future Empowerment) that is a collaboration between residents, business owners, and government agencies. Businesses of all sizes can participate in Project SAFE, and are also encouraged to provide technical assistance, financial resources, or in-kind services to other members of the community. Components of the program include grants and low interest loans to eligible homeowners or businesses which agree to use the funds to make their property more resistant to natural disasters; a hazard analysis and risk assessment of all single family homes and commercial businesses; a tool-lending library; incentives for owners who have already undertaken retrofit; a training course for contractors and inspectors; and the non-structural retrofit of low-income apartment units by trained youth volunteers.*

from $8,000 to $15,000 depending on the nature of the property, and most of the time the loan must be paid back over a seven-year period.

California Department of Insurance Grant Program

The CDI has also created a grant program for low and moderate income households. As of March 1st, 1998, out of a pool of over 640 applications, the Department initially approved 45 grant applications for Los Angeles County, six for Alameda County, and six for Humboldt County. The program has recently been expanded to five additional counties: San Diego, San Bernadino, Santa Cruz, Mendocino, and San Francisco.

FEMA Project Impact

Currently FEMA has underwritten an initiative called *Project Impact* to encourage communities to become resistant to disasters. The project is based on the premise that "lives can be saved, damage to property can be reduced significantly, and economic recovery can be accelerated by consistently building safer and stronger buildings, strengthening existing infrastructures, enforcing building codes, and making the proper preparations BEFORE a disaster occurs" (FEMA 1998b). Seven cities were initially chosen to participate in the program and it has recently been expanded to include fifty more.

FEMA provides seed money to help communities develop a mitigation program that is community-based and draws on the diverse resources and organizations present in that community. Building partnerships with the business and nonprofit organizations in a community is a key element of

■ *After the Northridge earthquake, California received a large infusion of hazard mitigation funds through FEMA's Hazard Mitigation Grant Program (Stafford Act Sections 409 and 404). These funds have been used by the state and local jurisdictions for a wide variety of innovative projects, including some projects to improve building performance. One city with many historic buildings received funding to evaluate the various building types for typical retrofit scenarios before proceeding with retrofit work. The state has encouraged cities and counties to identify essential buildings for retrofitting, including critical structures not covered by the Essential Building Services Act. Several cities used Phase I Hazard Mitigation funds to perform structural evaluations of their city halls, using outside engineering expertise. (In all three instances, mitigation funds were provided for subsequent retrofits.) A local jurisdiction is using Hazard Mitigation funds to develop a methodology for assessing and grading the seismic vulnerability of single family wood frame structures and determine appropriate retrofit solutions based on performance standards.*

Project Impact. Each city designs its program in light of its vulnerabilities to damage, as well as its particular resources to reduce those damages. *Project Impact* has brought about mitigation projects in places they would not otherwise have been started.

Stafford Act, Sections 409 and 404

Federal hazard mitigation money can be a major source of funding for improving building performance. Tied to a disaster, it has been particularly effective for California because of the large number of presidentially declared disasters in recent years. The Hazard Mitigation Grant Program was created under Section 404 of the Stafford Act. It states:

> The President may contribute up to 50 percent of the cost of hazard mitigation measures which the President has determined are cost-effective and which substantially reduce the risk of future damage, hardship, loss, or suffering in any area affected by a major disaster. Such measures shall be identified following the evaluation of natural hazards under Section 409 and shall be subject to approval by the President. The total of contributions under this section for a major disaster shall not exceed 10 percent of the estimated aggregate amounts of grants to be made under Section 406 with respect to such major disaster.

The evaluation of natural hazards under Section 409, also referred to as mitigation planning, is as follows:

> As a further condition of any loan or grant made under the provisions of this Act, the state or local government shall agree that the natural hazards in the areas in which the proceeds of the grants

or loans are to be used shall be evaluated and appropriate action shall be taken to mitigate such hazards, including safe land-use and construction practices. In accordance with standards prescribed or approved by the President after adequate consultation with the appropriate elected officials of general purpose local governments, and the State, shall furnish such evidence of compliance with this section as may be required by regulation.

Section 409 does not provide actual funding, but it requires that a mitigation plan be developed before Section 404 funding can be received.

These programs can be used to improve building performance, even buildings not damaged in the disaster. Section 404 offers federal funds, which may be used for 50 percent of the cost of earthquake strengthening in buildings not damaged in the disaster. Section 406 offers up to full repair costs for public and private nonprofit structures (depending on the severity of disaster impact). Recipients can negotiate for additional funds to upgrade the buildings to conform to codes.

Small Business Administration 504 Program

The Small Business Administration (SBA) 504 Certified Development Company (CDC) Program provides growing businesses with long-term, fixed-rate financing for major fixed assets, such as land and buildings. A Certified Development Company is a non-profit corporation set up to contribute to the economic development of its community or region. CDCs work with the SBA and private sector lenders to provide financing to

■ *The City of San Jose, California, used Community Development Block Grant (CDBG) funds to develop a Residential Seismic Safety Program, developing approaches to improving structural seismic safety for both single family and multi-unit residences. The single family element of the program is modeled after the City of San Leandro program (see page 45). Workshops are held for homeowners, including laboratory demonstrations, where participants can perform some of the tasks discussed in the morning (see photo). The multi-family element is currently under development. As noted by the program designers, while it is politically acceptable for government to inform residents about the potential risks associated with their privately owned property which they occupy, designating the multi-unit properties as potentially seismically at risk poses more difficult questions, including liability issues for owners and the government, and adverse effects on property values. The program is currently being designed to provide tools to owners to conduct a seismic evaluation of the property, and a cost-benefit analysis of retrofit. The city is also investigating possible financing mechanisms or financial incentives that would facilitate retrofit.*

(Text and photo adapted from Winslow and Vukazich 1998)

■ *"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 rehabilitate seismically a complex of four of its older office buildings partly using 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."

(Building Seismic Safety Council 1997, 8)

small businesses. Proceeds from the loans must be used for fixed asset projects including purchasing land and improvements, and construction of new facilities, or modernizing, renovating, or converting existing facilities. Loans are only available to owner-occupied commercial/industrial properties.

Housing and Community Development Block Grant (CDBG) Programs

These grants are administered by local jurisdictions and funded by the U.S. Department of Housing and Urban Development (HUD). They can be a very flexible source of funds, allowing jurisdictions to design and administer local retrofit programs. Los Angeles uses CDBG funds extensively for its retrofit program. However, the projects using this funding must comply with strict criteria, and generally must benefit low and moderate-income individuals.

Rental Rehabilitation Program

This HUD program transfers federal funds to state and local governments for use in (a) supporting the rehabilitation of existing residential units and (b) providing rental housing assistance to lower-income families. HUD's contribution for each rehabilitation project is limited to less than 50 percent of rehabilitation costs or between $5,000 and $8,500 (Olshansky and Glick 1997).

Tax Credits for Historic Preservation

The Federal Investment Tax Credit allows a 20 percent federal tax credit for restoring buildings listed in the National Register of Historic Places or for buildings that contribute to the character of a designated historic district. The work must be done according to *Standards for the Rehabilitation of Historic Buildings* (Olshansky and Glick 1997).

■ *After the Loma Prieta earthquake, a large number of damaged URM Single Room Occupancy hotels were closed and the tenants turned out into the streets. The owners of the SROs didn't have the money to repair the hotels and many walked away from their buildings. In both Oakland and San Francisco, nonprofit housing developers, committed to providing housing, were allowed to acquire the abandoned properties in order to repair and/or replace the SROs. In every case, the nonprofit knew how to find its way through the maze of federal and state housing funds available, and was able to put together finance packages for the work, often combing funding from as many as seven different sources. In the process of repair/replacement, each building was seismically upgraded. One nonprofit developer claims that the majority of seismic retrofit going on in older urban areas is done by non-profits.*

Tax Credits for Rehabilitation

There is also a 10 percent federal tax credit for rehabilitation of industrial or commercial buildings constructed before 1937. Strengthening an existing structural system seems to be recognized as a qualified rehabilitation expenditure. (Olshansky and Glick 1997).

Creating Effective Financial Programs

An experienced financial advisor notes that every property owner asks how property taxes will be affected by the seismic work (Clayton 1997). This major concern must be addressed in the creation of any type of program, even though some work does not raise property taxes.

Depending on the size and nature of the project, the financing may be a package put together from as many as five to seven different sources, each with their own, sometimes conflicting, regulations. Even an individual financing source can be cumbersome. For example, one municipal loan program has a 27-page application.

■ *Small amounts of seed money can be an effective incentive. The Oakland, California Diocese provides $1,000 to parishes to conduct their Phase I studies, and a $2,000 subsidy for their Phase II studies. This money has proven very helpful to encourage parishes to identify their seismic risk.*

Building owners are frequently not aware of existing incentives, even those that might be most helpful to them. For example, few property owners in California know of the property tax exemption available for seismic retrofit improvements to existing buildings described above. In order to take advantage of this program the owner must file papers with the county assessor, and the State Board of Equalization prescribes the manner and form for claiming the exemption. Neither county assessors nor the Board of Equalization is compensated in any manner for the time they must put into implementing this

Banks almost never commit to financing retrofit projects of unreinforced masonry buildings in older downtown areas, particularly when the area suffers from economic stagnation and is located immediately adjacent to a major fault. Banks will lend to their larger customers, but generally avoid fixed-asset real-estate financing, particularly when the subject property is not owner-occupied. In older downtowns this eliminates most URM properties.

A local California jurisdiction, using traditional municipal finance techniques, was unable to market either a tax-exempt or taxable bond, barring guarantee of all loans. The city approached individual banks but was refused assistance.

Through extensive in-depth negotiation, six banks (large, mid-size, and small) agreed to pool their exposure and contract with the city to commit $5 million to retrofit and rehabilitate 45 buildings within 500 feet of an active fault. Their cooperation was based upon city and redevelopment agency committing to financial support programs, providing staff to assist property owners, and packaging each of the loans for submission to the lenders. A knowledgeable legal and financial negotiating team was employed by the city to conduct negotiations and draft documents for all parties.

(Clayton 1997)

law, which may account for the minimal advertisement of its existence. There are no brochures available describing this program, and since there may be the perception on the part of county and state officials that it is taking money from already overstretched coffers, there is little enthusiasm for educating the public about the program's availability. A good program is not being utilized because it made no provisions for publicity.

Programs that are created under one set of market conditions and then implemented under another may end up being unattractive to prospective borrowers. A case in point is the San Francisco loan program which was designed for owners of unreinforced masonry buildings and was created with a long set of parameters in 1992, when market conditions were vastly different. A 10 percent loan in 1992 was considered favorable (Clayton 1997). In 1997, however, building owners can obtain better rates from private lending institutions and do not need to borrow money from the city. The number of strings attached to the funds also make them less attractive. The window of opportunity for setting up and utilizing financing programs is very short.

The order of pay out must also be considered. For example, a "first mortgage" lien is to be paid off first—before a second mortgage which is paid if there are assets remaining. Thus the security is not as secure for a second as it is for a first. Some local government loans financed by general obligation or revenue bonds want to be in first place, ahead of the first mortgage lien. Needless to say, if the holder of the first objects, he/she can call in the loan.

It is not advisable to structure one program that will cover all types of loans. For example, if a jurisdiction has 100 buildings where the average loan to complete a seismic rehabilitation is $25,000 or less, and one building where the loan is $1 million, those loans must be handled by different programs. The administrative costs are not the same and the loan structure is different. To reflect the needs of the group of properties affected, a package of loan programs would be more appropriate (Clayton 1997).

Large building projects have carefully crafted financing packages, but the financing may come from several sources and/or contain numerous conditions that can make it difficult to procure additional financing for rehabilitation and/or above-code construction.

Potential impediments to improved performance, related to financial aids

- Cumbersome process
- Rates for loans not affordable
- Lack of knowledge of existing incentives
- Problem with order of pay out
- Need to apply to many sources, some with conflicting regulations, instead of using just one source
- Design of program not reflecting current market conditions

Conditions that will make improved performance more likely, related to financial aids

- Funds that are easy to apply for and use
- Tax credits
- Tax deductibility
- Tax abatement
- Grants
- Low-interest loans
- Loan guarantees
- Subsidies

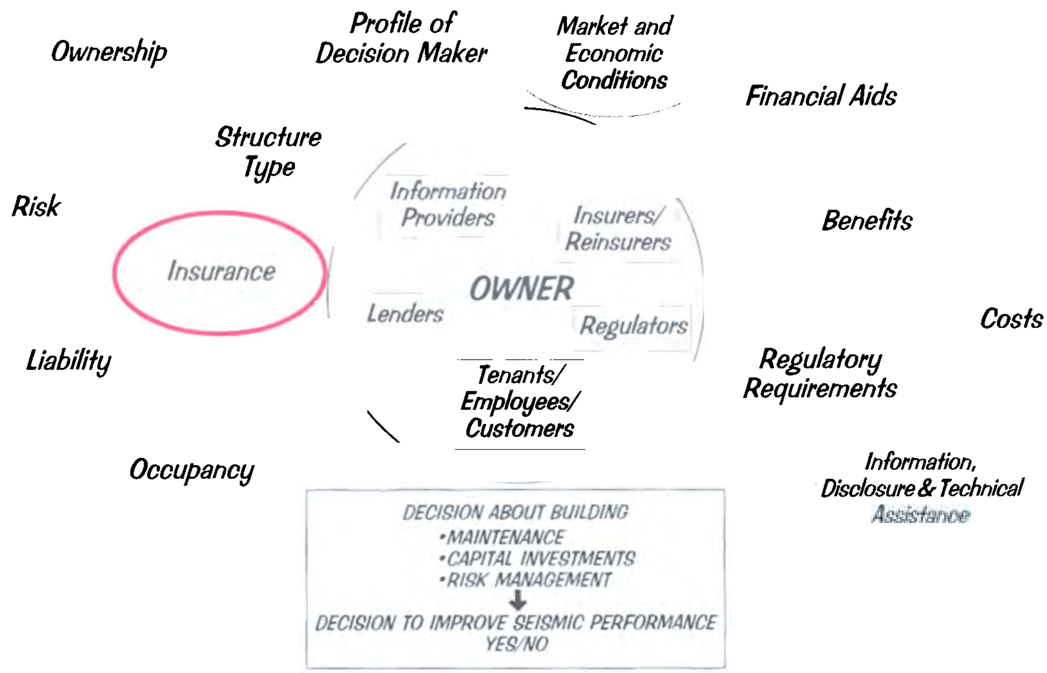


Figure THE DECISION-MAKING CONTEXT: KEY CONSIDERATIONS

INSURANCE

Insurance is an important consideration in managing earthquake risk and has significant implications for mitigation investment decisions. Given the interaction of insurance and mitigation decisions, it is important to discuss several related issues in some depth here. However, we should state clearly that insurance, while a potentially major component in the total risk management strategy for a building, is not in and of itself a technique to improve the seismic performance of a building. In fact, the availability of insurance may act as an impediment to taking action to improve a building's performance.

What Insurance Does

While the following discussion focuses primarily on residential insurance, commercial insurance is a major factor in how commercial property owners manage risk. There is some evidence that commercial insurance acts as an impediment to retrofit. As noted in a recent publication on steel frame buildings, "although the rates for property insurance and its availability are highly variable, earthquake insurance for commercial structures is currently priced very attractively, and for many owners, the most economical way to cover their potential losses is through purchase of insurance" (FEMA and SAC Joint Venture Steel Project 1998a, 14). Conversely, most governments are self-insured and that may be a factor in their motivation to improve seismic performance.

■ *Several large corporate owners in high-risk areas of California use insurance as their "mitigation" strategy. Rather than invest in the upgrading of buildings known to be vulnerable by professionals, or from experiences in other communities, decision makers have considered their risk and made a decision to rely on insurance policies. The assumption is that their insurer will replace or repair any damaged buildings. By itself insurance used in this manner is not mitigation. This approach doesn't address the issue of what might happen to tenants or building occupants in the event of an earthquake, or the issue of how long buildings can be closed before people will begin to use other alternatives and owners will lose their tenant/ client base.*

Earthquake insurance generally covers a portion of the shake damage to a structure from an earthquake. Commercial policies are also available for business interruption. Fire, homeowners multi-peril, and commercial multi-peril insurance cover any losses from fires resulting from an earthquake. Earthquake policies vary in terms of deductibles (ranging from 5 to 15 percent of losses), coverage of structures other than the primary structure, and limits on coverage of contents.

The California Earthquake Authority (CEA) was created in 1996. This new agency provides "mini" earthquake insurance policies to homeowners, with deductibles of 15 percent, content coverage limited to $5,000, a maximum of $1,500 in living expenses, and significantly higher premiums than previously charged by insurers. Some insurers offer "wraparound" coverage that covers some losses not insured by the CEA policy.

The funding for this new authority is interesting. None of the budget for the authority is provided by the state. The capital funding is a combination of cash contributions by insurers, premiums from policyholders, post-earthquake event assessments on insurers, reinsurance, possible sale of "act of god" bonds, bonds sold by the State Treasurer, and post-earthquake event surcharges on future earthquake insurance premiums. If the CEA's capital is exhausted, policyholders will receive pro rata payments. Insurers that do not make a commitment of capital to the CEA will not be allowed to place policies into the CEA. An insurer that is not a participant in the CEA can sell residential earthquake policies, but retains the risk in

■ *A leading manufacturer of tools used by the semi-conductor industry has activities centered in California's Santa Clara Valley and near Tokyo in Japan—both areas of very high seismicity. In order to control its earthquake risk to manageable levels, the company has selected a strategy that includes purchase of insurance but also includes design of new facilities and upgrade of existing facilities to minimize potential losses. Performance-based corporate design criteria, based on recently published FEMA Seismic Rehabilitation guidelines and the Structural Engineers Association of California Vision 2000 report were developed and implemented on a corporate basis. Upon construction of new facilities, project-specific performance criteria are selected based on potential business interruption. Design is conducted in accordance with the corporate performance criteria, which include guidelines for different facility performance goals. Existing facilities are upgraded in conformance with these criteria, as manufacturing upgrades are instituted. Peer review has been instituted as a standard part of the design process for both new and existing facilities.*

an earthquake. Commercial insurers are continuing to provide earthquake insurance outside the CEA. The new coverage is far more expensive and less comprehensive than what was previously available.

The success of the CEA will depend on the number of policyholders who choose to participate in the program and the occurrence of major, damaging earthquakes. At this point the number of policyholders in California has been dramatically reduced (about 1 million policies with CEA, as opposed to 2.5 million policies in place with various insurers at the time of the Northridge earthquake). As reported in the *San Francisco Chronicle* in November 1997, State Farm, the largest insurer in the state (with a fourth of the market), reported that 30 percent of its earthquake insurance customers declined the new coverage with CEA; at Allstate (second-largest insurer) the drop-off was 40 percent; and at Farmers (third-largest insurer) the drop-off was 62 percent (Louis 1997). Anecdotal evidence suggests that some homeowners declining CEA coverage are investing in mitigation as an alternative. There has as yet been no empirical corroboration of that.

Insurance as Incentive

How insurance can be used to promote improved seismic performance—or at least not to encourage decisions to ignore or increase risk—is currently of great interest in the risk management community. The price of insurance should reflect risk, and take into account mitigation, if it reduces the expected insurance losses on the structure or the uncertainty with respect to estimating expected losses.[3] The premium savings from mitigation, capitalized and amortized over the useful life of a structure, should, in theory, be considered in cost-benefit analysis of mitigation investments. These savings would be additional to the reduction in uninsured losses from mitigation that would otherwise be retained by the property owner. Alternately, insurers might offer broader coverage for mitigated structures.

However, many insurers are reluctant to offer premium discounts or other incentives for mitigation for two reasons. First, insurers contend that, if the base rate is inadequate, offering discounts will attract more policyholders and increase rather than reduce their losses. Second, insurers indicate it is difficult for them to determine an appropriate mitigation discount based on the information available. Yet there are a few insurers that do offer mitigation discounts and other incentives. One California company recently announced a residential earthquake insurance program that offers greater coverage and lower premiums than the CEA with proper retrofitting and for less hazardous locations. The company provides information on what retrofit work is required, and then asks for a licensed architect or engineer's signature that such work was conducted properly.

The CEA is required by state law to offer five percent reductions in premiums to homeowners who have strengthened their homes. Currently this discount is available on a pilot basis to homeowners in three counties who wish to retrofit their homes. Homeowners who have already retrofit their homes are also eligible to participate (CEA 1998).

Early in 1998 several insurance companies began competing with the CEA, offering more complete coverage for the same or slightly higher priced premiums than the CEA. One company offers a lower deductible (10 percent as opposed to CEA's 15 percent), coverage for detached structures, more coverage for contents (up to 50 percent of a policy's face value as compared to the $5,000 maximum of the CEA), and a maximum of $25,000 for post-earthquake living expenses as opposed to the maximum $1,500 from the CEA). The company reported sales of 500 policies in the first week. The company started with $25 million in capital, half provided by the reinsurer, Zurich Group. With the help of computer models, the company hopes to limit its losses to a maximum of $2.5 million by buying coverage from reinsurers around the world.

At the same time, there is the risk that some thinly capitalized insurers, attracted by high profits in years when losses are low, will undercut the market and fail to purchase adequate reinsurance. The owners of such an insurer could extract the profits and turn the company over to the state if it becomes insolvent due to a severe earthquake.[4]

[3] The expected loss is equal to the probability of a loss multiplied by the anticipated amount of the loss.

[4] The unfunded claims obligations of the insurer would be covered by the state's guaranty fund (up to $300,000 per claim) and the costs assessed against all insurers according to their relative premium volume.

> ■ "The ten insolvencies caused by Hurricane Andrew (an event causing insured losses roughly one-fifth the potential amount for a mega-catastrophe) exceeded the Florida guaranty fund's assessment limits and forced it to borrow funds against future assessments to pay claims. Legislation allowed the guaranty fund to issue a bond through the authority of the City of Homestead and help pay off this bond through a temporary two percent increase in guaranty fund assessment. In 1997, the bond was fully paid."
>
> (Klein 1998, 54)

Insurance and Earthquakes

Can insurance markets efficiently handle the risk of earthquakes? The primary problem for insurers is that their premium flows are relatively stable over time, but they must access large amounts of cash to pay claims when a catastrophe occurs. At present, it is difficult for insurers to accumulate funds for such a contingency for several reasons (EERI 1997; Russell and Jaffee 1996). Reinsurance can be purchased at intermediate layers of coverage, but it is difficult or expensive to acquire for the higher layers that would be needed for a severe earthquake. Financial markets are beginning to develop catastrophe securities that could fill this gap, but it may take some time before they develop sufficiently to provide the additional capacity or liquidity needed.

This has prompted interest in state (such as the CEA), multi-state, and federal catastrophe reinsurance pools to supplement private market capacity, at least for an interim period. State pools, properly structured, can provide a useful intermediate layer of coverage, but cannot provide sufficient capacity alone for a catastrophe. Multi-state pools have been discussed, but low- and moderate-risk states may be reluctant to participate, fearing that they would subsidize high-risk states. Several bills have been introduced in Congress that would establish some form of federal catastrophe reinsurance for earthquakes and hurricanes. Many insurers and other interest groups support federal legislation, but differ on where the layer of coverage should be provided and whether mitigation provisions should be part of the legislative package.

Solving the capacity problem is a necessary, but not sufficient, condition for efficient insurance markets. Insurers also must be able to charge adequate, actuarially based rates, manage their portfolio of risks through appropriate underwriting, and offer an array of insurance options to meet consumers' needs. Unfortunately, insurers' supply cutbacks and price increases following recent catastrophes have prompted regulatory and legislative restrictions in high-risk states. The use of computer modeling to guide insurers' decisions on underwriting and pricing introduces a new dimension with which regulators have struggled.

While the governmental response to the severe market changes is understandable from a political perspective, excessive market restrictions will exacerbate market availability and cost problems in the long run (Klein 1998). Such restrictions discourage insurers from entering or staying in the market and distort property owners' incentives to invest in mitigation. States must embark on a deliberate path of regulatory reforms to achieve a sustainable market equilibrium. Additionally, regulators must continue adequate solvency oversight to ensure that insurers do not incur excessive financial risk due to their catastrophe exposure.

The question of whether property owners should be legally required to carry earthquake insurance is a difficult one. Such a requirement should not be necessary if property owners are prevented from passing on uninsured losses to taxpayers. However, political support for post-disaster financial assistance and tax deductions for catastrophe losses is strong. It does make sense for lenders and loan guarantors to require earthquake insurance and/or mitigation as a condition for securing their interests, and to prevent the banking system from subsidizing uninsured and unmitigated catastrophe losses stemming from loan defaults.

Potential impediments to improved performance, related to insurance

- Moral hazard resulting from insurance which results in underinvestment in mitigation[5]
- Insurers' difficulties in determining and offering appropriate mitigation incentives

Conditions that would make improved performance more likely, related to insurance

- Consideration of upgrading of buildings in insurer underwriting decisions
- Risk-based pricing of insurance that reflects the effects of mitigation
- The ability to offer an array of insurance options to meet consumers' needs

[5] Moral hazard is an insurance term that refers to the phenomenon that having insurance diminishes the insured's incentives to act safely (e.g., mitigate hazards).

CHANGING THE CONTEXT: NEW AND BETTER INCENTIVES

■ *An excellent example of how an incentive package could be crafted, combining various types of incentives to encourage action, can be found in the city of St. Helena, California. There, the city council adopted an unreinforced masonry ordinance in April 1998. This ordinance has several components:*

- *the adoption of the 1994 Uniform Code for Building Conservation (UCBC), with amendments based on local conditions, as the minimum building standard for the retrofit of URM buildings;*
- *a ten-year mandatory period of compliance with penalties for non-compliance;*
- *establishment of the Building Conservation Advisory and Appeals Board*
- *adoption of alternative design review procedures*
- *an incentive program to help offset costs including:*

  creating a National Register Historical District to provide a 20 percent Federal tax credit for qualifying work on a contributing historical building within the district;

  establishing an appeals board for building, disabled access, and fire issues;

  adopting the Mills Act and develop a Mills Act program available to property owners that will provide property tax reduction for owners of historic properties for a minimum ten-year period;

  providing zoning incentives;

  reimbursing architectural and engineering fees of up to $1.00 per square foot of building area;

  waive plan check and building permit fees.

The schedule for compliance, using the incentives as "carrots," is as follows:

Years 1–3: If owners apply for permits, then full incentives are available

Year 4: Full non-structural plan review fees are required. Building permit fees reduced by 50 percent. Architectural and engineering reimbursement no longer available.

Year 5–8: Only Mills Act contract available.

Years 9–10: No incentives are available. City starts repair work; lien is placed on property.

A COHERENT PROGRAM

The preceding sections have illustrated the array of considerations that inform a decision to improve the seismic performance of a building. These considerations and the stakeholders involved in the decision cannot be isolated from each other. This interconnectedness has important implications for proposed new incentives. Clearly, the owner is influenced by the insurer, the lender, the government (either as regulator, financer or information provider), nongovernmental information providers (professional associations, colleagues), tenants, and employees.

Incentives should be evaluated as a package. This report illustrates that an incentive directed at one impediment or leveraging one condition will not have as much impact as a *set* of incentives. It is also important to keep in mind that some incentives may ultimately be more effective if combined with regulations or mandates.

The incentive package proposed below is not meant to be segmented into individual components. It may be that the components can be adopted individually, but the whole package should be the goal. For example, it might be relatively easy to develop an educational campaign, but it will be much more successful when combined with financial incentives or regulatory relief. Some of the recommendations pose research questions that need to be addressed before specific financial incentives can be definitively recommended. Further evaluation is needed to determine how each could fit within a particular state or community context, or in what way it would motivate owners.

Stakeholders can provide different incentives for building owners. For example, local government can provide a fee waiver to a homeowner; insurance companies can provide reduced premiums or deductibles; regulators can allow insurance companies to charge adequate rates which in turn will allow them to offer discounts for mitigation.

There are three components to a coherent incentive package: (1) build on currently available incentives; (2) develop a process to encourage greater investment in improved seismic performance of buildings; and (3) create new and potentially more effective incentives.

Build on Current Incentives

Throughout this report there are examples of currently used incentives. (Please note that while these examples are primarily from California, these programs could be modified and adopted in any state.) The public and private sectors need to consider that, by adopting a number of these incentives, it is possible to create a stronger program. Among the incentives referred to in the text are the following:

Public Sector Incentives

- community-based education and technical assistance programs
- density bonuses
- waiver of fees
- modifying parking requirements and other requirements or restrictions
- transfer of development rights
- formation of hazard abatement districts
- formation of redevelopment districts or historic districts
- technical assistance
- use of tax increment financing
- subsidies for engineering analyses
- loan program
- disclosure of earthquake risk, particularly at time of sale

Private Sector Incentives

- subsidy for design study
- donated engineering design, labor, materials
- identification of hazard areas and vulnerable types of structures
- offering loans
- offering insurance

Encourage Investment in Seismic Performance

Education, information dissemination, and technical assistance are important to decisions involving improved seismic performance of a building. Owners and other stakeholders need models, better information, and help from various quarters. For example:

> Federal, state, and local governments should lead by example and seismically strengthen their own structures in a visible manner. Use the projects as an opportunity to educate building owners about improved performance options and costs, through media coverage, displays, and workshops.
>
> Educational campaigns should encourage owners to take advantage of positive conditions to improve performance:
>
> ✓ Upgrade when the building is vacant
> ✓ Upgrade as part of a larger remodel
> ✓ Upgrade as part of scheduled maintenance

An important analysis was commissioned in 1996 by the Portland Development Commission, the City of Portland Bureau of Buildings, and the League of Oregon Cities to estimate the fiscal and economic impacts on the state and local governments from proposed financial incentives the State of Oregon was considering. The study examined the effect of the proposed incentives on redevelopment activity and on tax revenues for the state and local governments. It also analyzed the likely long-term property tax, investment, employment, and other benefits resulting from the rehabilitation work. As a result of this comprehensive analysis, the authors proposed an income tax incentive that would allow up to 35 percent of the cost of seismic rehabilitation to be credited from Oregon income taxes. The credits could be carried forward for up to ten years. The authors calculate the average annual cost to the state of the income tax incentive would be approximately $20.9 million, or 0.05 percent of the 1996 general fund revenues of $3.853 billion. They calculate that the property tax abatement would result in $3.3 million per year less in property taxes but that the value of the improvements accompanying the seismic retrofit would be approximately $8.5 million per year, and these improvements would generate additional property tax revenue of $1.3 million. Such studies serve as a model for other state policy analyses.

(Adapted from ECONorthwest 1997)

- ✓ Upgrade in a booming economy
- ✓ Upgrade when the building has the ability to carry additional debt
- ✓ Upgrade when the market for the building, product or service has the ability to cover the costs

- Federal, state, and local agencies and professional associations should continue to develop educational materials/programs that help owners gain a better understanding of the risk. It is clear that there are still many owners who do not believe their building is at risk in an earthquake. More emphasis should be placed on programs targeted at building owners, focusing on issues of particular concern to them such as liability, business interruption, and recovery financing options (or lack thereof).

- Local governments must develop building inventories that building owners can use in their risk management decisions. Better information about risk is a necessity.

- Work with professional associations to encourage participation of public officials and others in learning from earthquake programs. There is nothing so compelling as witnessing the damage caused by earthquakes to stimulate an individual's commitment to seismic safety. Political leaders who visit earthquake sites gain an increased understanding of what an earthquake might do to their community. Such visits, accompanied by knowledgeable design professionals, should be encouraged.

Develop ombudsman programs at the local or state levels to help owners through the entire process. One of the impediments to improved seismic performance is the complexity of the process, particularly when government grants or loans are used, or when trying to comply with government regulations. Someone who could assist each owner through the entire process of strengthening—from evaluation to selection of an engineer and architect, to negotiation of the financing, and overseeing of construction—would be invaluable to encourage to each owner to embark on the process.

Create More Effective Incentives

- Encourage states and the federal government to fund and conduct research on the effectiveness and impacts of proposed new incentives. For example, more information is needed in order to calculate costs to state and federal treasuries of various financial incentives such as tax credits, accelerated depreciation, and deductions for retrofit work. Such studies should be comprehensive and include costs for earthquake response and recovery if building performance is not improved.

- Work is needed to evaluate existing government policies that may act as impediments to improved seismic performance. These include federal tax laws, some disaster assistance policies, and bonding limitations. Modifications will be possible by working with stakeholders, champions, and legislators. The impact to the treasury and/or to taxpayers of removing these impediments also needs to be evaluated.

Encourage design professionals and regulators to support lenders and insurers by providing technical information and by recognizing and understanding the place of seismic safety in the lenders' and insurers' investment decisions.

- Encourage lenders to accept greater responsibility in promoting the improved seismic performance of buildings. This could include requiring evidence of improved performance before issuing a mortgage; requiring PML studies for all investments; offering discounts for improved performance, such as reduced points or a lower loan guarantee fee; and increasing the Loan-to-Value ratio to 85 percent so that borrowers could use the additional 5 percent to improve the seismic performance of their buildings. Lenders should also be encouraged to add the costs of improving the performance of the building to the loan, requiring buyers to perform the work within a time limit.

- Encourage insurers to support the improved seismic performance of buildings. If changes in insurance policy require regulatory or other policy changes, other stakeholders should work with the insurance community to insure such changes take place. Recommended policy changes might include promoting the passage of earthquake insurance that requires mitigation, and offering discounts for improved performance.

Encourage insurance regulators to support the goal of improving the seismic performance of buildings and to modify regulations to allow insurers to develop policies that reflect this goal.

- Encourage states and the federal government to develop effective tax incentives for improved seismic performance. This might include a ten percent tax credit, accelerated depreciation for retrofit work, and deductions for retrofit work (as opposed to just deducting for losses after an earthquake). As noted above, additional research needs to be conducted on the impact of such tax changes on state and federal treasuries.

- Encourage states and the federal government to investigate the feasibility of a revolving loan fund to finance mitigation work. Such a loan fund could be supported primarily by funds from the borrowers.

■ A number of coalitions can be found in the earthquake and natural hazards community. FEMA's Project Impact encourages communities to build partnerships with public and private sector organizations as the key to long-term success in hazard mitigation. In Oregon a coalition formed to address the problem of improving expected seismic performance of buildings. The Oregon Seismic Rehabilitation Task Force has representation from each of the various stakeholder groups in the state. Formed as partial settlement of an anti-trust civil suit related to the availability and cost of liability insurance was the Public Entity Risk Institute. This nonprofit organization was created to be a catalyst in the risk management field and a vehicle for allocating greater resources to key needs in risk management.

Another example of coalition-building can be found in the engineering community. There, the Structural Engineering Institute of the American Society of Civil Engineers, the National Council of Structural Engineers Associations, and the Council of American Structural Engineers have collectively created working partnerships to improve both how they practice and how their practice affects the built environment and the public. These three organizations represent over 20,000 practicing structural engineers, researchers, and academics. Their cooperation should lead to improved use and understanding of construction codes, improved design and detailing on construction drawings, and improved construction and inspection. These existing coalitions provide starting points for building the extensive partnerships necessary to develop effective incentives for improved seismic performance in buildings.

THE NEXT STEPS

Hold a Workshop

In order to maximize the probability that these and other incentives be developed and adopted, we propose that an invited workshop be held with representation from all the potential stakeholders. This workshop would bring together policy setters from the insurance, lending, engineering, construction, and regulatory communities, as well as information providers and representatives of tenants and employee groups. The workshop would work toward setting a national agenda for the development and implementation of an effective set of incentives for the improved seismic performance of buildings.

Coalition Building

We anticipate that growing out of this workshop would be a potentially powerful coalition. Owners, lenders, engineers, insurers, government regulators, information providers, and tenants all have a stake in reducing losses in future earthquakes and should participate actively in the development of incentives. Each of these groups has networks, professional associations, and colleagues to lobby and/or involve in discussions on regulations, procedures, and practices. Working together, these groups could serve as a powerful advocacy group to develop a blueprint for improved seismic performance of buildings that would be available to state and local governments as well as organizations in the private sector. Once such a coalition is established, regular communication and discussion among the participants will allow strategic consideration of the kinds of incentives proposed above.

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