



Risk Management Series

Incremental Seismic Rehabilitation of Office Buildings

Providing Protection to People and Buildings

December 2003



FEMA

FEMA 397

RISK MANAGEMENT SERIES

Incremental
Seismic Rehabilitation
of Office Buildings

PROVIDING PROTECTION TO PEOPLE AND BUILDINGS



FEMA

www.fema.gov

Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of FEMA. Additionally, neither FEMA or any of its employees makes any warrantee, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, product, or process included in this publication. Users of information from this publication assume all liability arising from such use.

Acknowledgements

Principal Authors:

Frederick Krimgold, Virginia Tech Center for Disaster Risk Management, Virginia Polytechnic Institute and State University

David Hattis, Building Technology Incorporated

Melvyn Green, Melvyn Green & Associates Inc.

Contributors:

Milagros Kennett, FEMA, Project Officer, Risk Management Series Publications

John Harrald, GWU

Charles Scawthorn, ABS Consulting
Medhi Setareh, VT

Rene Van Dorp, GWU

William Whiddon, BTI

Project Advisory Panel:

Daniel Abrams, University of Illinois

Daniel Butler, National Retail Federation

John Coil, John Coil Associates

Joseph Donovan, Carr America

James Harris, National Multi Housing Council

Randal Haslam, Jordan School District, Utah

James Malley, Degenkolb Engineers

Mike Mehrain, URS Dames & Moore

Anthony Moddesette, UC Davis Medical Center

Lawrence Reaveley, University of Utah

Technical Review:

Chris Poland, Degenkolb Engineers

Daniel Shapiro, SOHA Engineers

Production:

Lee-Ann Lyons and Amy Siegel, URS Group, Inc.

Contents

- Executive Summary** i
- Foreword** iii
- Preface** iv
- Introduction** vi
- How to Use This Manual** viii
- PART A Critical Decisions for Earthquake Safety in Office Buildings** A-1
 - A.1 Is There an Earthquake Hazard for Your Office Buildings? A-1
 - A.2 Are Your Office Buildings Safe? A-3
 - A.3 What Can Be Done to Reduce Earthquake Risk in Existing Vulnerable Office Buildings? A-5
 - A.4 Incremental Seismic Rehabilitation of Existing Office Buildings A-6
- PART B Planning and Managing the Process for Earthquake Risk Reduction in Existing Office Buildings** B-1
 - Introduction B-1
 - B.1 Integrating the Efforts of Facility Management, Risk Management, and Financial Management B-2
 - B.2 Integrating Incremental Seismic Rehabilitation into the Facility Management Process B-3
 - B.2.1 A Model of the Facility Management Process for Existing Office Buildings B-3
 - B.2.2 Elements of an Incremental Seismic Rehabilitation Program B-3
 - B.2.2.1 Due Diligence Analysis B-4
 - B.2.2.1 Initial Integration Opportunities B-4
 - B.2.2.3 Seismic Screening B-4
 - B.2.2.4 Seismic Evaluation B-5

	B.2.2.5	Developing a Risk Reduction Policy	B-5
	B.2.2.6	Seismic Rehabilitation Planning for Specific Buildings	B-5
	B.2.2.7	Staging Seismic Rehabilitation Increments	B-8
	B.2.2.8	Coordination With Tenant Work	B-9
	B.2.2.9	Budget Packaging	B-9
	B.2.2.10	Bond Packaging	B-10
	B.2.2.11	Seismic Rehabilitation Project Management	B-10
	B.2.3	Integration into the Office Facility Management Process	B-10
B.3		Opportunities for Seismic Risk Reduction in Support of Integrating Incremental Seismic Rehabilitation into the Facility Management Process	B-11
	B.3.1	Responding to Occupant Concerns	B-12
	B.3.2	Emergency Management/Response Planning	B-12
	B.3.3	Emergency Management/Mitigation Planning	B-13
	B.3.4	Developing a Risk Reduction Policy	B-13
	B.3.5	Incorporating Federal and State Mandates and Programs	B-13
	B.3.6	Coordinating with Risk and Insurance Managers	B-13
	B.3.7	Coordinating with Lenders	B-14
	B.3.8	Becoming Familiar with Applicable Codes	B-14
	B.3.9	Establishing and Maintaining a Roster of Design Professionals	B-14
	B.3.10	Negotiating Code Enforcement	B-14
B.4		Preparing a Plan for the CEO and the Board	B-15
	B.4.1	Getting Started	B-15
	B.4.2	Getting Started Plus	B-15
	B.4.3	Getting Started with a Jump Start	B-15
B.5		Additional Components of a Comprehensive Earthquake Safety Program	B-16
	B.5.1	Building Contents Mitigation	B-16
	B.5.2	Earthquake Drills	B-16
PART C		Tools for Implementing Incremental Seismic Rehabilitation in Existing Office Buildings	C-1
		Introduction	C-1
		Guide to Sections C.1 and C.2	C-1
	C.1	How to Use Engineering Services	C-2
		Seismic Screening and Evaluation	C-2
		Incremental Seismic Rehabilitation Planning and Design	C-2
		Construction Period Support	C-3
		Coordination with Tenant Work	C-3

	Continuity of Building Documentation	C-3
	Fees for Professional Services	C-4
C.2	Discovering Integration Opportunities for Incremental Seismic Rehabilitation	C-4
	Introduction	C-4
	Categories of Maintenance and Capital Improvement Projects	C-4
	Work Descriptions and Matrices of Seismic Performance Improvement Opportunities	C-5
	Definitions of Seismic Performance Improvements	C-7
	Simplified Information on Integration Opportunities	C-8
C.2.1	Roofing Maintenance and Repair/Re-Roofing	C-8
C.2.2	Exterior Wall and Window Maintenance/ Façade Modernization	C-10
C.2.3	Public Area Modernization	C-12
C.2.4	Fire and Life Safety Improvements	C-14
C.2.5	New Technology Accommodation	C-16
C.2.6	Tenant Alterations and Improvements	C-18
C.2.7	Underfloor and Basement Maintenance and Repair	C-20
C.2.8	HVAC Upgrade and Energy Conservation	C-22
C.2.9	Hazardous Materials Abatement	C-23
C.2.10	Definitions of Seismic Performance Improvements	C-23
Appendix I.	Additional Information on Office Building Facility Management	App I-1
	Introduction: Typical Facility Management for Office Buildings	App I-1
1.	The ACQUISITION Phase of Office Facility Management	App I-2
2.	The REDEVELOPMENT Phase of Office Facility Management	App I-4
3.	The Current Building USE Phase of Office Facility Management	App I-6
4.	The PLANNING Phase of Office Facility Management	App I-8
5.	The Maintenance and Rehabilitation BUDGETING Phase of Office Facility Management	App I-10
6.	The Maintenance and Rehabilitation FUNDING Phase of Office Facility Management	App I-12
7.	The Maintenance and Rehabilitation IMPLEMENTATION Phase of Office Facility Management	App I-14
Appendix II.	Integration Opportunities for Incremental Seismic Rehabilitation for Small Organizations and Individual Owners	App II-1

Executive Summary

Earthquakes are a serious threat to office safety and pose a significant potential liability to office building owners. Office buildings in 39 states are vulnerable to earthquake damage. Unsafe existing buildings expose office building owners and tenants to the following risks:

- *Death and injury of tenants, occupants, and visitors*
- *Damage to or collapse of buildings*
- *Damage to and loss of furnishings, equipment, and other building contents*
- *Disruption of office functions and building operations*

The greatest earthquake risk is associated with existing office buildings that were designed and constructed before the use of modern building codes. For many parts of the United States, this includes buildings built as recently as the early 1990s.

Although vulnerable office buildings need to be replaced with safe, new construction or rehabilitated to correct deficiencies, for many building owners new construction is limited, at times severely, by budgetary constraints, and seismic rehabilitation is expensive and disruptive. However, **incremental seismic rehabilitation**, an innovative approach that phases in a series of discrete rehabilitation actions over a period of several years, is an effective, affordable, and non-disruptive strategy for responsible mitigation action. It can be integrated efficiently into ongoing facility maintenance and capital improvement operations to minimize cost and disruption. The strategy of incremental seismic rehabilitation makes it possible to get started now on improving earthquake safety in your office building inventory.

This manual provides owners of office buildings, be they Real Estate Investment Trusts (REITs), pension funds, partnerships, individuals, or other forms of ownership, with the information necessary to assess the seismic vulner-

ability of their buildings and to implement a program of incremental seismic rehabilitation for those buildings. The manual consists of three parts:

Part A, Critical Decisions for Earthquake Safety in Office Buildings, is for owner senior executives, board members, and policy makers who will decide on allocating resources for earthquake mitigation.

Part B, Planning and Managing the Process for Earthquake Risk Reduction in Existing Office Buildings, is for facility managers, risk managers, and financial managers, or those responsible for these areas of management, who will initiate and manage seismic mitigation measures.

Part C, Tools for Implementing Incremental Seismic Rehabilitation in Existing Office Buildings, is for facility managers, or those otherwise responsible for facility management, who will implement incremental seismic rehabilitation programs.

To get the most out of this manual:

- Communicate the importance of assessing your building inventory's risks and pass this manual on to staff members responsible for facility management, risk management, and financial planning. Specify that they develop an analysis of the current seismic risk of your buildings and a strategy for risk reduction.
- Promptly initiate a program of earthquake risk reduction in your buildings located in an earthquake-prone zone that were not designed and constructed to meet modern building codes.
- Consider incremental seismic rehabilitation as a cost-effective means to protect the buildings and, most importantly, the safety of tenants, visitors, and staff, because it is a technically and financially manageable strategy that minimizes disruption of office building operations.

Foreword

The concept of seismically rehabilitating buildings in discrete segments, as resources become available or as part of a structural renovation program, was pioneered by the Federal Emergency Management Agency (FEMA) and a Virginia Polytechnic Institute/Building Technology Inc. team that, in the early 1990s, published *Existing School Buildings – Incremental Seismic Retrofit Opportunities*, FEMA 318. Lack of resources at the time, however, restricted application of this promising concept to a few states in the Pacific Northwest and to a single occupancy or use category: schools. FEMA is now pleased to make available a manual on office buildings. Further, the team is also preparing a series of manuals that will address seven additional building uses: schools (an updated version), hospitals, retail establishments, multi-family dwellings, emergency management facilities, warehousing/distribution centers, and hotels/motels. A separate manual will serve the needs of design professionals and building officials and will be applicable across all occupancy categories.

FEMA gratefully acknowledges the dedicated efforts of all members of the team: the Virginia Polytechnic Institute and State University (the prime contractor); the Project Advisory Panel; Project Consultants; Building Technology Inc.; EQE Inc.; Melvyn Green & Associates Inc.; the Institute for Crisis Disaster and Risk Management of the George Washington University; and URS Group, Inc. The FEMA Project Officer adds his sincerest appreciation for the excellent support of this multi-disciplinary team.

The Federal Emergency Management Agency

Preface

This manual is intended to assist office building owners' personnel responsible for funding and operating existing office buildings across the United States. This publication and its companion documents are the products of a Federal Emergency Management Agency (FEMA) project to develop the concept of incremental seismic rehabilitation—that is, building modifications that reduce seismic risk by improving seismic performance and that are implemented over an extended period, often in conjunction with other repair, maintenance, or capital improvement activities.

The manual was developed after the project team analyzed the management practices of office building owners of varying sizes located in various seismic zones in different parts of the United States. It focuses on the identified concerns and decision making practices of owners and managers of Class A, B, or C buildings, be they REITs, pension funds, partnerships, individuals, or other types of owners.

This manual is part of a set of manuals intended for building owners, managers, and their staff:

- *Incremental Seismic Rehabilitation of School Buildings (K-12), FEMA 395*
- *Incremental Seismic Rehabilitation of Hospital Buildings, FEMA 396*
- *Incremental Seismic Rehabilitation of Office Buildings, FEMA 397*
- *Incremental Seismic Rehabilitation of Multifamily Apartment Buildings, FEMA 398*
- *Incremental Seismic Rehabilitation of Retail Buildings, FEMA 399*
- *Incremental Seismic Rehabilitation of Hotel and Motel Buildings, FEMA 400*
- *Incremental Seismic Rehabilitation of Storage Buildings, FEMA 401*
- *Incremental Seismic Rehabilitation of Emergency Buildings, FEMA 402*

Each manual in this set addresses the specific needs and practices of a particular category of buildings and owners, and guides building owners and managers through a process that will reduce earthquake risk in their building inventory. The manuals answer the question, as specifically as possible: “What is the most affordable, least disruptive, and most effective way to reduce seismic risk in existing buildings?” By using the process outlined in these manuals, building owners and managers will become knowledgeable clients for implementing incremental seismic rehabilitation specifically geared to their building use category.

In addition to this set of manuals, there is a companion manual, *Engineering Guideline for Incremental Seismic Rehabilitation*, FEMA 420. It is intended to assist architects and engineers who provide services to building owners and contains the information necessary for providing consulting services to owners for implementing incremental seismic rehabilitation. Architects and engineers using that handbook will be effective consultants serving a knowledgeable owner. Together they will be in a position to implement an effective incremental seismic rehabilitation program.

You may be liable for earthquake deaths and injuries in your older office buildings.

The 1933 Long Beach, California Earthquake destroyed at least 70 schools and damaged 420 more, 120 of them seriously. As a direct response, California enacted the Field Act, which established strict design and construction standards for new schools in California. But what about all the existing schools that were vulnerable to earthquakes? It took over 30 years to solve this problem, but more than just the passage of time was required.

In 1966 the Attorney General of California issued an opinion indicating that school boards were responsible for ensuring non-Field Act buildings were examined, and if schools were found to be unsafe and the board did not make the necessary corrections to make them safe, **the individual school board members were personally liable.** The opinion received widespread media attention. School boards, then realizing the gravity of the situation, became quite concerned about the structural condition of their pre-Field Act public school buildings. Legislative action soon followed. The Governor signed the Greene Act in 1967, which relieved the individual school board members of personal liability *only once the board initiated the process of examining existing buildings and established an intent to carry through to completion all the steps necessary for their replacement or repair.*

This responsibility may apply to office building owners as well. You too may be liable for earthquake deaths and injuries in your older buildings, but can you wait 30 years to act? This manual provides you with the tools to assess your vulnerability and to find cost-effective ways to reduce your liability today.

Introduction

Office Buildings, Risk, and Liability

Owners of office buildings face a wide array of risks. These risks range from fire to terrorist attack. Risk management for office buildings typically is driven by experience; we recognize the need for fire safety and terrorism insurance, but the risk of catastrophic loss due to a damaging earthquake is more difficult to understand or to anticipate. Earthquakes are low-probability high-consequence events. Though they may occur only once in the life of a building, they can have devastating, irreversible consequences.

Moderate earthquakes occur more frequently than major earthquakes. Nonetheless, moderate earthquakes can cause serious damage to building contents and nonstructural building systems, serious injury to occupants and staff, and disruption of building operations. Major earthquakes can cause catastrophic damage including structural collapse and massive loss of life. Those responsible for office building safety must understand and manage these risks, particularly risks that threaten the lives of tenants, occupants, visitors, and staff.

Earthquake risk is the product of hazard exposure and building vulnerability, as shown in the following equation:

$$\text{RISK} = \text{HAZARD} \times \text{VULNERABILITY}$$

To manage earthquake risk in existing office buildings, one must understand the earthquake hazard and reduce building vulnerability.

This manual is designed to give decision makers the framework and information for making informed decisions about investing in earthquake

risk management measures. It is structured to follow the decision making process of existing planning and management practices and will help you evaluate financial, safety, and strategic planning priorities.

Owners of office buildings may vary greatly in size, wealth, and technical capability. Some have comprehensive long-term facility management, maintenance, and development plans. Some have none. The successful implementation of improved earthquake safety should be part of a comprehensive approach to building safety and multi-hazard mitigation.

Failure to address earthquake risk leaves the office building owner exposed to potential losses, disruption, and liability for deaths and injuries. While purchasing insurance may protect owners from financial losses and liability, it still leaves them susceptible to disruption as well as deaths and injuries. Only building rehabilitation can reduce losses, deaths, and injuries, as well as control liability and disruption. However, single-stage seismic rehabilitation can be expensive and disruptive. Incremental seismic rehabilitation can reduce that cost and disruption.

Considering Incremental Seismic Rehabilitation

The incremental rehabilitation approach to seismic risk mitigation focuses on improvements that will decrease the vulnerability of office buildings to earthquakes at the most appropriate and convenient times in the life cycle of those buildings. The approach clarifies, as specifically as possible, what is the most affordable, least disruptive, and most effective way to reduce seismic risk in your buildings.

Prior to initiating a program of incremental seismic rehabilitation, an owner must first address the following three questions:

- Are your office buildings located in a seismic zone?
- Are these buildings vulnerable to earthquakes?
- What can you do to reduce earthquake risk in existing vulnerable buildings?

This manual will help you find the right answers.

How to Use This Manual

Critical Decisions: Office building owner senior executives, board members, and similar policy makers should read Part A. Section A.1 provides a general understanding of the earthquake hazards faced by an office building owner. Section A.2 provides an overview of how the seismic vulnerability of office buildings and resultant losses can be estimated. Section A.3 provides an overview of the actions an owner can take to reduce earthquake risk, including incremental seismic rehabilitation. Section A.4 details how to implement the concept of incremental seismic rehabilitation, including the additional benefits of integrating incremental seismic rehabilitation with other maintenance and capital improvement projects. **By understanding these four sections, the office building owner's top management can establish a policy of seismic risk reduction and initiate a more specific, objective, and cost-effective program of incremental seismic rehabilitation by its technical staff.**

Program Development: Those responsible for the office building owner's facility, risk, and financial management should read Parts A and B, paying particular attention to Part B. Sections B.1 through B.3 provide detailed guidance on **how the initiation of a program of incremental seismic rehabilitation can fit into the ongoing facility management process** used by the owner organization and its office buildings, and indicate specific activities you can undertake. A separate Appendix I, Additional Information on Office Building Facility Management, is provided at the end of this manual for those seeking more information on facility management. It contains a discussion of specific phases of the facility management process and activities for office building owners seeking further detail.

Project Implementation: Owner organization and office building facility managers should read Part C in addition to Parts A and B. Section C.1 provides guidance on using the consulting services of architects and engineers in implementing a program of incremental seismic rehabilitation. Section C.2 discusses specific opportunities for **combining increments of seismic rehabilitation with other maintenance and capital improvement projects**. A separate Appendix II, Integration Opportunities for Incremental Seismic Rehabilitation for Small Organizations and Individual Owners, is provided at the end of this manual for owners with limited professional facility management. It contains a simplified presentation of specific opportunities that can be identified on the basis of a quick evaluation by a design professional. A companion manual for design professionals has been developed to provide technical guidance for the detailed design of specific rehabilitation projects.