



*Risk Management Series*

# Incremental Seismic Rehabilitation of Multifamily Apartment Buildings

Providing Protection to People and Buildings

*February 2004*



**FEMA**

FEMA 398



**RISK MANAGEMENT SERIES**

Incremental Seismic  
Rehabilitation of Multifamily  
Apartment Buildings

**PROVIDING PROTECTION TO PEOPLE AND BUILDINGS**



**FEMA**

**[www.fema.gov](http://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

- Foreword and Scope** ..... i
- How to Use This Manual** ..... iv
- PART A Critical Decisions for Earthquake Safety in Multifamily Buildings** ..... A-1
  - Introduction ..... A-1
  - A.1 Is There an Earthquake Hazard for Your Multifamily Buildings? ..... A-2
  - A.2 Are Your Multifamily Buildings Safe? ..... A-4
  - A.3 What Can Be Done to Reduce Earthquake Risk in Existing Vulnerable Multifamily Buildings? ..... A-6
  - A.4 Incremental Seismic Rehabilitation of Existing Multifamily Buildings ..... A-7
  - Summary of Part A ..... A-9
  - Recommended Actions ..... A-9
- PART B Planning and Managing the Process for Earthquake Risk Reduction in Existing Multifamily 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 Multifamily Buildings ..... B-3
    - B.2.2 Elements of an Incremental Seismic Rehabilitation Program ..... B-3
    - B.2.3 Integration into the Multifamily 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-10
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-12
B.3.4	Developing a Risk Reduction Policy .....	B-12
B.3.5	Incorporating Federal and State Mandates and Programs .....	B-12
B.3.6	Coordinating with Risk and Insurance Managers .....	B-13
B.3.7	Coordinating with Lenders .....	B-13
B.3.8	Becoming Familiar with Applicable Codes .....	B-13
B.3.9	Establishing and Maintaining a Roster of Design Professionals .....	B-13
B.3.10	Negotiating Code Enforcement .....	B-14
B.4	Additional Components of a Comprehensive Earthquake Safety Program .....	B-14
B.4.1	Building Contents Mitigation .....	B-14
B.4.2	Earthquake Drills .....	B-14
B.5	Preparing a Plan for the CEO and the Board .....	B-15
	Summary of Part B .....	B-16
	Recommended Actions .....	B-16
<b>PART C</b>	<b>Tools for Implementing Incremental Seismic Rehabilitation in Existing Multifamily Buildings</b> .....	<b>C-1</b>
	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
	Continuity of Building Documentation .....	C-3
	Fees for Professional Services .....	C-3
C.2	Discovering Integration Opportunities for Incremental Seismic Rehabilitation .....	C-4
	Categories of Maintenance and Capital Improvement Projects .....	C-4
	Work Descriptions and Matrices of Seismic Performance Improvement Opportunities .....	C-4
	Definitions of Seismic Performance Improvements .....	C-7
	Simplified Information on Integration Opportunities .....	C-7
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	Kitchen and Bathroom Modernization .....	C-14
C.2.5	Fire and Life Safety Improvements .....	C-16
C.2.6	Underfloor and Basement Maintenance and Repair .....	C-18
C.2.7	HVAC Upgrade and Energy Conservation .....	C-20
C.2.8	Hazardous Materials Abatement .....	C-21
C.2.9	Definitions of Seismic Performance Improvements .....	C-21
	Summary of Part C .....	C-25
	Recommended Actions .....	C-25
<b>Appendix I.</b>	<b>Additional Information on Multifamily Building Facility Management</b> .....	App I-1
	Introduction: Typical Facility Management for Multifamily Buildings .....	App I-1
1.	The ACQUISITION Phase of Multifamily Facility Management .....	App I-2
2.	The REDEVELOPMENT Phase of Multifamily Facility Management .....	App I-4
3.	The Current Building USE Phase of Multifamily Facility Management .....	App I-6
4.	The PLANNING Phase of Multifamily Facility Management .....	App I-8
5.	The Maintenance & Rehabilitation BUDGETING Phase of Multifamily Facility Management .....	App I-11
6.	The Maintenance & Rehabilitation FUNDING Phase of Multifamily Facility Management .....	App I-13
7.	The Maintenance & Rehabilitation IMPLEMENTATION Phase of Multifamily Facility Management .....	App I-15
<b>Appendix II.</b>	<b>Integration Opportunities for Incremental Seismic Rehabilitation for Small Organizations and Individual Owners</b> .....	App II-1



## Foreword and Scope

*Earthquakes are a serious threat to safety in multifamily apartment buildings and pose a significant potential liability to building owners. Multifamily buildings in 39 states are vulnerable to earthquake damage. Unsafe existing buildings expose multifamily 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 rental and occupancy functions and other building operations*

The greatest earthquake risk is associated with existing multifamily 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 multifamily 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**, proposed in this manual, is an innovative approach that phases in a series of discrete rehabilitation actions over a period of several years. It is an effective, affordable, and non-disruptive strategy for responsible mitigation actions that can be integrated efficiently into ongoing facility maintenance and capital improvement operations to minimize cost and disruption.

This manual 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. It provides owners of Class A, B, or C multifamily 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 vulnerability 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 Multifamily Buildings**, is for owners' 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 Multifamily 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 Multifamily Buildings**, is for facility managers, or those otherwise responsible for facility management, who will implement incremental seismic rehabilitation programs.

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.

## How to Use This Manual

**Critical Decisions:** Multifamily building owners' 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 a multifamily building owner. Section A.2 provides an overview of how the seismic vulnerability of multifamily 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 multifamily 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 multifamily 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 multifamily buildings, and indicates specific activities you can undertake. A separate Appendix I, Additional Information on Multifamily Building Facility Management, is provided at the end of this manual for those seeking more information on facility management. It contains a discussion of the specific phases of the facility management process and activities for multifamily building owners seeking further detail.

**Project Implementation:** Owner organization and multifamily 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. The companion manual for design professionals, *Engineering Guideline for Incremental Seismic Rehabilitation*, FEMA 420, provides technical guidance for the detailed design of specific rehabilitation projects.

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 multifamily building operations.

