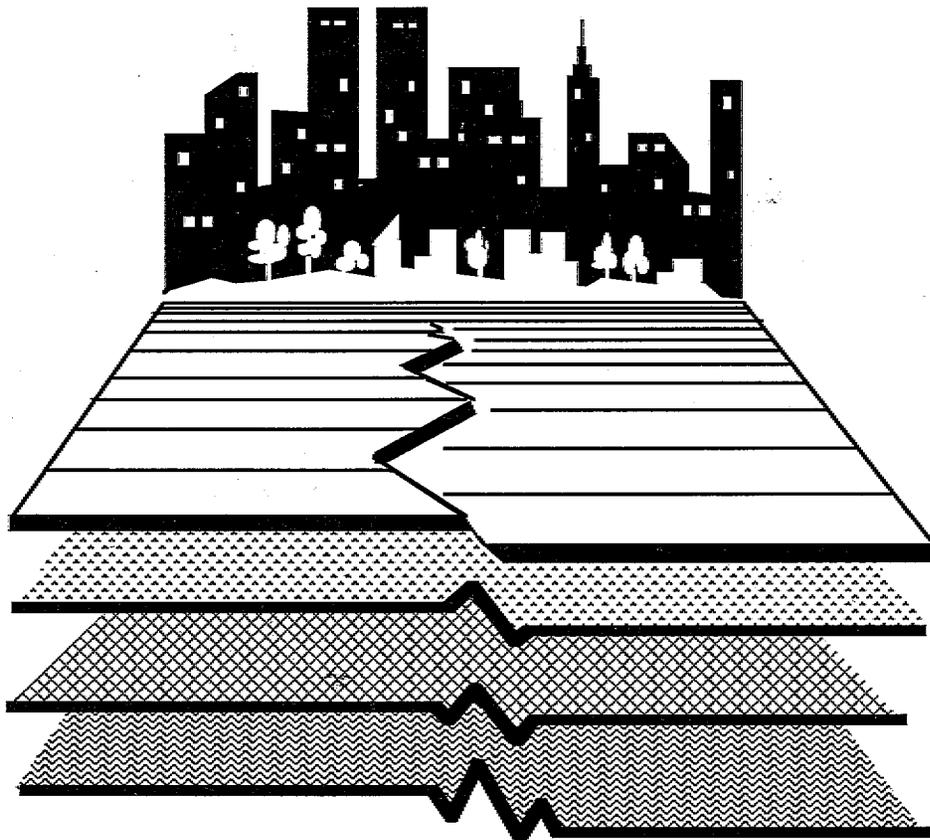


# Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model

*Volume 1 - A User's Manual*



Issued by FEMA in furtherance of the  
Decade for Natural Disaster Reduction.



NATIONAL EARTHQUAKE HAZARDS

REDUCTION PROGRAM

**SEISMIC REHABILITATION  
OF FEDERAL BUILDINGS:  
A BENEFIT-COST MODEL**

**VOLUME 1  
A USER'S MANUAL**

Prepared for the Federal Emergency Management Agency  
Under Contract No. EMW-92-6-3976

by

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## **FEMA FORWARD**

FEMA is pleased to have sponsored the development of these two new publications (Seismic Rehabilitation of Federal Buildings: A Benefit-Cost Model. Volume 1: A User's Manual and Volume 2: Supporting Documentation), and the associated software, for inclusion in the series of documents dealing with the seismic safety of existing buildings. In this endeavor, FEMA gratefully acknowledges the expertise and efforts of VSP Associates, Inc., its consultants, the Advisory Panel, and Ms. Diana Todd of the National Institute of Standards and Technology, Technical Advisor to FEMA.

**The Federal Emergency Management Agency**

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## EXECUTIVE SUMMARY

FEMA's program for reducing seismic hazards in existing buildings includes development of a body of consensus engineering criteria on how to evaluate and reduce the seismic vulnerability of existing buildings. This comprehensive program is also concerned with the societal and economic aspects of the seismic rehabilitation of existing buildings. This report and accompanying software present a benefit-cost model for the seismic rehabilitation of Federal buildings.

**Is it worth it?** This is the primary question about seismic rehabilitation projects which are designed to reduce expected damages and casualties from future earthquakes. Decision making about the prospective seismic rehabilitation of existing Federal buildings may be difficult because of the myriad of complex and often contentious engineering and public policy issues involved. In many cases, life safety (avoiding casualties) is the principal motivation for implementing seismic rehabilitation programs, while in some instances property protection or continued functionality of important government services may be the driving economic force.

Benefit-cost analysis is a powerful tool which can help determine whether the future benefits of a prospective seismic rehabilitation are sufficient to justify the present costs of the project. The benefit-cost methodology in this report (and accompanying software) provides estimates of the benefits (i.e., avoided future damages, losses and casualties) of the seismic rehabilitation of Federal government buildings. The benefit-cost model is also applicable to state and local government buildings.

There are two primary intended applications for this methodology: first, to roughly screen or prioritize a large list of buildings and second, to evaluate in detail one or more specific alternatives on a single building for which detailed engineering analysis exists. To screen a large list of buildings, a rough analysis could be made using typical or default data built into the computer program, although incorporation of more detailed building specific information would improve the validity of the results. To evaluate one or more specific rehabilitation options for a single building, detailed engineering analyses of the alternatives are essential.

The benefit-cost methodology presented in this report is intended for use by facility managers, design professionals (engineers and architects), and others involved in decision making about the seismic rehabilitation of Federal buildings. A technical background is not a prerequisite for using the methodology. However, a working knowledge about the general principles and terminologies relevant to the seismic performance of buildings, and some basic personal computer skills are necessary.

The benefit-cost model performs the necessary calculations to determine how the expected future benefits of a specific seismic rehabilitation project compare to the costs. The model also generates detailed scenario damage estimates of expected

damages, other economic losses, and casualties per earthquake event (as a function of Modified Mercalli Intensity, MMI, and effective peak ground acceleration, PGA). These scenario damage, loss, and casualty estimates may prove useful to decision makers.

Benefit-cost analysis does not provide an absolute answer about whether or not to undertake the seismic rehabilitation of a building because decisions about rehabilitations usually depend on a great many factors and policy decisions well outside the confines of benefit-cost analysis. For example, basic policy decisions about what level of life safety and what level of post-earthquake performance are desired cannot be decided by a benefit-cost program. Furthermore, the quality of input data and the resulting uncertainty in benefit-cost results must be considered in all decision making using the results of benefit-cost analysis. Notwithstanding these limitations, the benefit-cost model presented in this report is a powerful tool to assist decision-makers concerned with the seismic rehabilitation of Federal buildings.

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