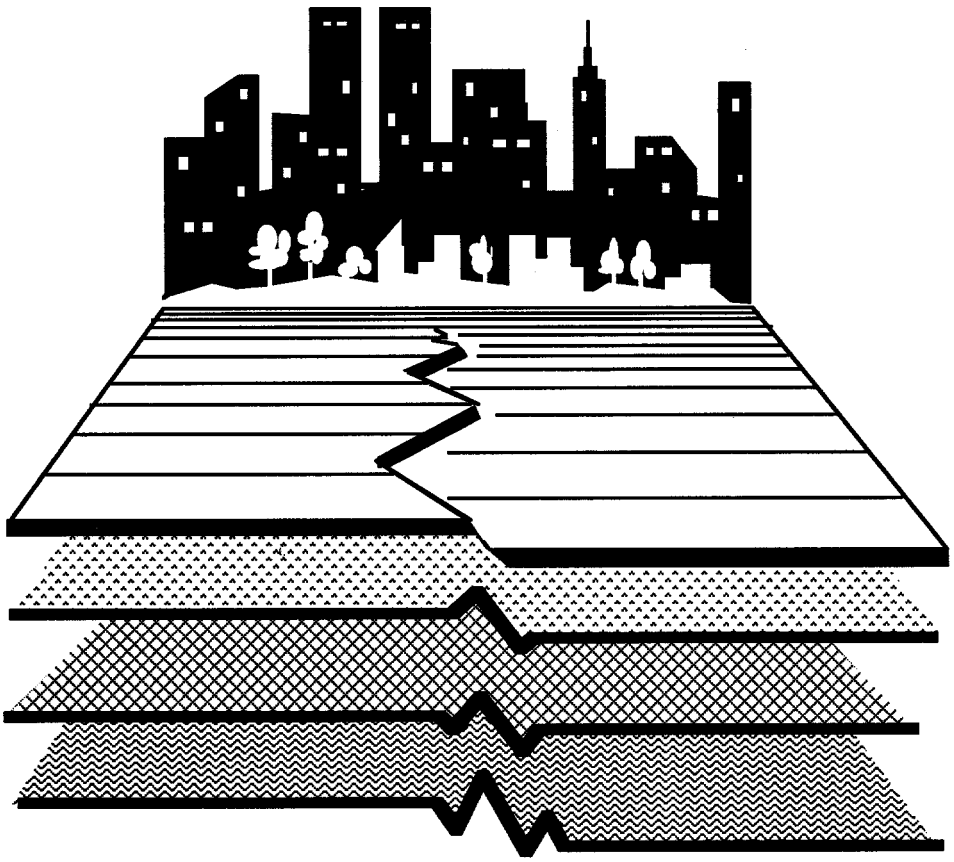
NEHRP COMMENTARY ON THE GUIDELINES FOR THE SEISMIC REHABILITATION OF BUILDINGS



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

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

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

BOARD OF DIRECTION: 1997

A council of the National Institute of Building Sciences

BSSC
Seismic
Rehabilitation
Project

NEHRP COMMENTARY ON THE GUIDELINES FOR THE SEISMIC REHABILITATION OF BUILDINGS (FEMA PUBLICATION 274)

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BUILDING SEISMIC SAFETY COUNCIL
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In Memoriam

The Building Seismic Safety Council, the Applied Technology Council, the American Society of Civil Engineers, and the Federal Emergency Management Agency wish to acknowledge the significant contribution to the *Guidelines* and to the overall field of earthquake engineering of the participants in the project who did not live to see this effort completed:

Richard Atkinson

Peter Gergely

Roger Scholl

The built environment has benefited greatly from their work.

Foreword

The volume you are now holding in your hands, the *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*, and its companion *Commentary* volume, are the culminating manifestation of over 13 years of effort. They contain systematic guidance enabling design professionals to formulate effective and reliable rehabilitation approaches that will limit the expected earthquake damage to a specified range for a specified level of ground shaking. This kind of guidance applicable to all types of existing buildings and in all parts of the country has never existed before.

Since 1984, when the Federal Emergency Management Agency (FEMA) first began a program to address the risk posed by seismically unsafe existing buildings, the creation of these *Guidelines* has been the principal target of FEMA's efforts. Prior preparatory steps, however, were much needed, as was noted in the 1985 *Action Plan* developed at FEMA's request by the ABE Joint Venture. These included the development of a standard methodology for identifying at-risk buildings quickly or in depth, a compendium of effective rehabilitation techniques, and an identification of societal implications of rehabilitation.

By 1990, this technical platform had been essentially completed, and work could begin on these *Guidelines*. The $8 million, seven-year project required the varied talents of over 100 engineers, researchers and writers, smoothly orchestrated by the Building Seismic Safety Council (BSSC), overall manager of the project; the Applied Technology Council (ATC); and the American Society of Civil Engineers (ASCE). Hundreds more donated their knowledge and time to the project by reviewing draft documents at various stages of development and providing comments, criticisms, and suggestions for improvements. Additional refinements and improvements resulted from the consensus review of the *Guidelines* document and its companion *Commentary* through the balloting process of the BSSC during the last year of the effort.

No one who worked on this project in any capacity, whether volunteer, paid consultant or staff, received monetary compensation commensurate with his or her efforts. The dedication of all was truly outstanding. It seemed that everyone involved recognized the magnitude of the step forward that was being taken in the progress toward greater seismic safety of our communities, and gave his or her utmost. FEMA and the FEMA Project Officer personally warmly and sincerely thank everyone who participated in this endeavor. Simple thanks from FEMA in a Foreword, however, can never reward these individuals adequately. The fervent hope is that, perhaps, having the *Guidelines* used extensively now and improved by future generations will be the reward that they so justly and richly deserve.

The Federal Emergency Management Agency

Preface

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

The major objectives of the project were to develop a set of technically sound, nationally applicable guidelines (with commentary) for the seismic rehabilitation of buildings; develop building community consensus regarding the guidelines; and develop the basis of a plan for stimulating widespread acceptance and application of the guidelines. The guidelines documents produced as a result of this project are expected to serve as a primary resource on the seismic rehabilitation of buildings for the use of design professionals, educators, model code and standards organizations, and state and local building regulatory personnel.

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

While overall management has been the responsibility of the BSSC, responsibility for conduct of the specific project tasks is shared by the BSSC with ASCE and ATC. Specific BSSC tasks were completed under the guidance of a BSSC Project Committee. To ensure project continuity and direction, a Project Oversight Committee (POC) was responsible to the BSSC Board of Direction for accomplishment of the project objectives and the conduct of project tasks. Further, a Seismic Rehabilitation Advisory Panel reviewed project products as they developed and advised the POC on the approach being taken, problems arising or anticipated, and progress made.

Three user workshops were held during the course of the project to expose the project and various drafts of the *Guidelines* documents to review by potential users of the ultimate product. The two earlier workshops provided for review of the overall project structure and for detailed review of the 50-percent-complete draft. The last workshop was held in December 1995 when the *Guidelines* documents were 75 percent complete. Participants in this workshop also had the opportunity to attend a tutorial on application of the guidelines and to comment on all project work done to date.

Following the third user workshop, written and oral comments on the 75-percent-complete draft of the documents received from the workshop participants and other reviewers were addressed by the authors and incorporated into a pre-ballot draft of the *Guidelines* and *Commentary*. POC members were sent a review copy of the 100-percent-complete draft in August 1996 and met to formulate a recommendation to the BSSC Board of Direction concerning balloting of the documents. Essentially, the POC recommended that the Board accept the documents for consensus balloting by the BSSC member organization. The Board, having received this recommendation in late August, voted unanimously to proceed with the balloting.

The balloting of the *Guidelines* and *Commentary* occurred between October 15 and December 20, 1996, and a ballot symposium for the voting representatives of BSSC member organizations was held in November during the ballot period. Member organization voting representatives were asked to vote on each major subsection of the *Guidelines* document and on each chapter of the *Commentary*. As required by BSSC procedures, the ballot provided for four responses:

"yes," "yes with reservations," "no," and "abstain." All "yes with reservations" and "no" votes were to be accompanied by an explanation of the reasons for the vote and the "no" votes were to be accompanied by specific suggestions for change if those changes would change the negative vote to an affirmative.

Although all sections of the *Guidelines* and *Commentary* documents were approved in the balloting, the comments and explanations received with "yes with reservations" and "no" votes were compiled by the BSSC for delivery to ATC for review and resolution. The ATC Senior Technical Committee reviewed these comments in detail and commissioned members of the technical teams to develop detailed responses and to formulate any needed proposals for change reflecting the comments. This effort resulted in 48 proposals for change to be submitted to the BSSC member organizations for a second ballot. In April 1997, the ATC presented its recommendations to the Project Oversight Committee, which approved them for forwarding to the BSSC Board. The BSSC Board subsequently gave tentative approval to the reballoting pending a mail vote on the entire second ballot package. This was done and the reballoting was officially approved by the Board. The second ballot package was mailed to BSSC member organizations on June 10 with completed ballots due by July 28.

All the second ballot proposals passed the ballot; however, as with the first ballot results, comments submitted with ballots were compiled by the BSSC for review by the ATC Senior Technical Committee. This effort resulted in a number of editorial changes and six additional technical changes being proposed by the ATC. On September 3, the ATC presented its recommendations for change to the Project Oversight Committee that, after considerable discussion, deemed the proposed changes to be either editorial or of insufficient substance to warrant another ballot. Meeting on September 4, the BSSC Board received the recommendations of the POC, accepted them, and approved preparation of the final documents for transmittal to the Federal Emergency Management Agency. This was done on September 30, 1997.

It should be noted by those using this document that recommendations resulting from the concept work of the BSSC Project Committee have resulted in initiation of a case studies project that will involve the development of seismic rehabilitation designs for at least 40 federal buildings selected from an inventory of buildings determined to be seismically deficient under the implementation program of Executive Order 12941 and determined to be considered "typical of existing structures located throughout the nation." The case studies project is structured to:

- Test the usability of the *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* in authentic applications in order to determine the extent to which practicing design engineers and architects find the *Guidelines* documents themselves and the structural analysis procedures and acceptance criteria included to be presented in understandable language and in a clear, logical fashion that permits valid engineering determinations to be made, and to evaluate the ease of transition from current engineering practices to the new concepts presented in the *Guidelines*.

- Assess the technical adequacy of the *Guidelines* design and analysis procedures. Determine if application of the procedures results (in the judgment of the designer) in rational designs of building components for corrective rehabilitation measures. Assess whether these designs adequately meet the selected performance levels when compared to existing procedures and in light of the knowledge and experience of the designer. Evaluate whether the *Guidelines* methods provide a better fundamental understanding of expected seismic performance than do existing procedures.

- Assess whether the *Guidelines* acceptance criteria are properly calibrated to result in component designs that provide permissible values of such key factors as drift, component strength demand, and inelastic deformation at selected performance levels.

- Develop empirical data on the costs of rehabilitation design and construction to meet the *Guidelines* "basic safety objective" as well as the higher performance levels included. Assess whether the anticipated higher costs of advanced engineering analysis result in worthwhile savings compared to the cost of constructing more conservative design solutions necessary with a less systematic engineering effort.

- Compare the acceptance criteria of the *Guidelines* with the prevailing seismic design requirements for new buildings in the building location to determine whether requirements for achieving the *Guidelines* "basic safety objective" are equivalent to or more or less stringent than those expected of new buildings.

Feedback from those using the *Guidelines* outside this case studies project is strongly encouraged. Further, the curriculum for a series of education/training seminars on the *Guidelines* is being developed and a number of seminars are scheduled for conduct in early 1998. Those who wish to provide feedback or with a desire for information concerning the seminars should direct their correspondence to: BSSC, 1090 Vermont Avenue, N.W., Suite 700, Washington, D.C. 20005; phone 202-289-7800; fax 202-289-1092; e-mail bssc@nibs.org. Copies of the *Guidelines* and *Commentary* can be obtained by phone from the FEMA Distribution Facility at 1-800-480-2520.

The BSSC Board of Direction gratefully acknowledges the contribution of all the ATC and ASCE participants in the *Guidelines* development project as well as those of the BSSC Seismic Rehabilitation Advisory Panel, the BSSC Project Committee, and the User Workshop participants. The Board also wishes to thank Ugo Morelli, FEMA Project Officer, and Diana Todd, FEMA Technical Advisor, for their valuable input and support.

Eugene Zeller
Chairman, BSSC Board of Direction

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