NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

Second Edition

RAPID VISUAL SCREENING OF BUILDINGS FOR POTENTIAL SEISMIC HAZARDS: A HANDBOOK

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Preface

In August 1999 the Federal Emergency Management Agency (FEMA) awarded the Applied Technology Council (ATC) a two-year contract to update the FEMA 154 report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*, and the companion FEMA-155 report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation*, both of which were originally published in 1988.

The impetus for the project stemmed in part from the general recommendation in the FEMA 315 report, *Seismic Rehabilitation of Buildings: Strategic Plan 2005*, to update periodically all existing reports in the FEMA-developed series on the seismic evaluation and rehabilitation of existing buildings. In addition, a vast amount of information had been developed since 1988, including: (1) new knowledge about the performance of buildings during damaging earthquakes, including the 1989 Loma Prieta and 1994 Northridge earthquakes; (2) new knowledge about seismic hazards, including updated national seismic hazard maps published by the U. S. Geological Survey in 1996; (3) other new seismic evaluation and damage prediction tools, such as the FEMA 310 report, *Handbook for the Seismic Evaluation of Buildings – a Prestandard*, (an updated version of FEMA 178, *NEHRP Handbook for the Seismic Evaluation of Existing Buildings*), and HAZUS, FEMA's tool for estimating potential losses from natural disasters; and (4) experience from the widespread use of the original FEMA 154 *Handbook* by federal, state and municipal agencies, and others.

The project included the following tasks: (1) an effort to obtain users feedback, which was executed through the distribution of a voluntary FEMA 154 Users Feedback Form to organizations that had ordered or were known to have used FEMA 154 (the Feedback Form was also posted on ATC's web site); (2) a review of available information on the seismic performance of buildings, including a detailed review of the HAZUS fragility curves and an effort to correlate the relationship between results from the use of both the FEMA 154 rapid visual screening procedure and the FEMA 178 detailed seismic evaluation procedures on the same buildings; (3) a Users Workshop midway in the project to learn first hand the problems and successes of organizations that had used the rapid visual screening procedure on buildings under their jurisdiction; (4) updating of the original FEMA 154 *Handbook* to create the second edition; and (5) updating of the original FEMA 155 *Supporting Documentation* report to create the second edition.

This second edition of the FEMA 154 *Handbook* provides a standard rapid visual screening procedure to identify, inventory, and rank buildings that are potentially seismically hazardous. The scoring system has been revised, based on new information, and the *Handbook* has been shortened and focused to facilitate implementation. The technical basis for the rapid visual screening procedure, including a summary of results from the efforts to solicit user feedback, is documented in the companion second edition of the FEMA 155 report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation.*

ATC gratefully acknowledges the personnel involved in developing the second editions of the FEMA 154 and FEMA 155 reports. Charles Scawthorn served as Co-Principal Investigator and Project Director. He was assisted by Kent David, Vincent Prabis, Richard A. Ranous, and Nilesh Shome, who served as Technical Consultants. Members of the Project Advisory Panel, who provided overall review and guidance for the project, were: Thalia Anagnos, John Baals, James R. Cagley (ATC Board Representative), Melvyn Green, Terry Hughes, Anne S. Kiremidjian, Joan MacQuarrie, Chris D. Poland, Lawrence D. Reaveley, Doug Smits, and Ted Winstead. William T. Holmes served as facilitator for the Users Workshop, and Keith Porter served as recorder. Stephanie A. King verified the Basic Structural Hazard Scores and the Score Modifiers. A. Gerald Brady, Peter N. Mork, and Michelle Schwartzbach provided report editing and production services. The affiliations of these individuals are provided in the list of project participants.

ATC also gratefully acknowledges the valuable assistance, support, and cooperation provided by Ugo Morelli, FEMA Project Officer. In addition, ATC acknowledges participants in the

FEMA 154 Users Workshop, which included, in addition to the project personnel listed above, the following individuals: Al Berstein, U. S. Bureau of Reclamation; Amitabha Datta, General Services Administration; Ben Emam, Amazon.com; Richard K. Eisner, California Office of Emergency Services; Ali Fattah, City of San Diego; Brian Kehoe, Wiss Janney Elstner Associates, Inc.; David Leung, City and County of San Francisco; Douglas McCall, Marx/Okubo; Richard Silva, National Park Service; Howard Simpson, Simpson Gumpertz & Heger Inc.; Steven Sweeney, U. S. Army Civil Engineering Research Laboratory; Christine Theodooropoulos, University of Oregon; and Zan Turner, City and County of San Francisco. Those persons who responded to ATC's request to complete the voluntary FEMA 154 Users Feedback form are also gratefully acknowledged.

Christopher Rojahn, Principal Investigator
ATC Executive Director

Summary and Application

This FEMA 154 Report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook,* is the first of a two-volume publication on a recommended methodology for rapid visual screening of buildings for potential seismic hazards. The technical basis for the methodology, including the scoring system and its development, are contained in the companion FEMA 155 report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation*. Both this document and the companion document are second editions of similar documents published by FEMA in 1988.

The rapid visual screening procedure (RVS) has been developed for a broad audience, including building officials and inspectors, and government agency and private-sector building owners (hereinafter, the "RVS authority"), to identify, inventory, and rank buildings that are potentially seismically hazardous. Although RVS is applicable to all buildings, its principal purpose is to identify (1) older buildings designed and constructed before the adoption of adequate seismic design and detailing requirements, (2) buildings on soft or poor soils, or (3) buildings having performance characteristics that negatively influence their seismic response. Once identified as potentially hazardous, such buildings should be further evaluated by a design professional experienced in seismic design to determine if, in fact, they are seismically hazardous.

The RVS uses a methodology based on a "sidewalk survey" of a building and a Data Collection Form, which the person conducting the survey (hereafter referred to as the screener) completes, based on visual observation of the building from the exterior, and if possible, the interior. The Data Collection Form includes space for documenting building identification information, including its use and size, a photograph of the building, sketches, and documentation of pertinent data related to seismic performance, including the development of a numeric seismic hazard score.

Once the decision to conduct rapid visual screening for a community or group of buildings has been made by the RVS authority, the screening effort can be expedited by pre-planning, including the training of screeners, and careful overall management of the process.

Completion of the Data Collection Form in the field begins with identifying the primary structural lateral-load-resisting system and structural materials of the building. Basic Structural Hazard Scores for various building types are provided on the form, and the screener circles the appropriate one. For many buildings, viewed only from the exterior, this important decision requires the screener to be trained and experienced in building construction. The screener modifies the Basic Structural Hazard Score by identifying and circling Score Modifiers, which are related to observed performance attributes, and which are then added (or subtracted) to the Basic Structural Hazard Score to arrive at a final Structural Score, *S*. The Basic Structural Hazard Score, Score Modifiers, and final Structural Score, *S*, all relate to the probability of building collapse, should severe ground shaking occur (that is, a ground shaking level equivalent to that currently used in the seismic design of new buildings). Final *S* scores typically range from 0 to 7, with higher *S* scores corresponding to better expected seismic performance.

Use of the RVS on a community-wide basis enables the RVS authority to divide screened buildings into two categories: those that are expected to have acceptable seismic performance, and those that may be seismically hazardous and should be studied further. An *S* score of 2 is suggested as a "cut-off", based on present seismic design criteria. Using this cut-off level, buildings having an *S* score of 2 or less should be investigated by a design professional experienced in seismic design.

The procedure presented in this *Handbook* is meant to be the preliminary screening phase of a multi-phase procedure for identifying potentially hazardous buildings. Buildings identified by this procedure must be analyzed in more detail by an experienced seismic design professional. Because rapid visual screening is designed to be performed from the street, with interior inspection not always possible, hazardous details will not always be visible, and seismically hazardous buildings may not be identified as such. Conversely, buildings initially identified as potentially hazardous by RVS may prove to be adequate.

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