

Morelli, Ugo (1998 [2004] 'Seismic safety of existing buildings', in *Disaster Management Programs for Historic Sites*, eds Dirk H. R. Spennemann & David W. Look. San Francisco and Albury: Association for Preservation Technology (Western Chapter) and The Johnstone Centre, Charles Sturt University. Pp. 65-67.

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Seismic safety of existing buildings

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Since 1984, the Federal Emergency Management Agency (FEMA) has had underway a comprehensive, closely coordinated program to develop a body of building practices that would increase the ability of existing buildings to withstand the forces of earthquakes. Societal implications and issues related to the use of these improved practices have also been examined. At a cost of about US\$20 million, two dozen publications, software programs and audio-visual training materials have already been produced and distributed. The intended audience includes design professionals, buildings regulatory personnel, local and state planning and development personnel, high-level managers, master builders, educators, researchers and the general public. The program has proceeded along separate, but parallel, approaches in dealing with private-sector and with federal buildings.

Private-sector buildings

Already available to private-sector practitioners and other interested parties is a 'technical platform' of consensus criteria on how to deal with some of the major engineering aspects of seismic rehabilitation of buildings. This technical material is contained in a trilogy, with supporting documentation, completed in 1989:

- a method for rapid identification of buildings that might be hazardous in case of an earthquake that can be conducted without gaining access to the buildings themselves;

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- a methodology for a more detailed evaluation of a building that identifies structural flaws that have caused collapse in past earthquakes and might do so again in future earthquakes; and
- a compendium of the most commonly used techniques of seismic rehabilitation.

In addition to these engineering topics, the program has also been concerned with societal implications of seismic rehabilitation. In addition to two editions of a study of seismic rehabilitation costs, it has also developed benefit/cost models and associated software for application to both private-sector buildings and federal buildings. For the use of decision makers, major socio-economic issues that are likely to arise in a locality that undertakes seismic rehabilitation of its building stock have been identified, together with ways to array them, and methods to analyze them.

The culminating activity in this field will be the completion in late 1997 of the *Guidelines for Seismic Rehabilitation of Buildings and Commentary*, a comprehensive set of nationally applicable and consensus-backed technical criteria intended to ensure that buildings will better withstand earthquakes. This is a multi-year, multi-million dollar effort that represents a first of its kind in the United States and will fill a significant gap in the segment of the National Earthquake Hazards Reduction Program dealing with the seismic safety of existing buildings. These publications will allow practitioners to choose design approaches consistent with different levels of seismic safety as required by geographic location, performance objective, type of building, occupancy, or other relevant considerations. Included will be analytical techniques that will yield reliable estimates of the seismic performance of rehabilitated buildings.

Before being issued, the two documents will be given consensus review by representatives of a broad spectrum of users, including the construction industry; building regulatory organizations; building owners and occupants groups; academic and research institutions; financial establishments; local, state and federal levels of government; and the general public. This process is intended to ensure their national applicability and encourage their widespread acceptance and use by practitioners. It is expected that, with time, this set of guidelines will be adapted and adopted by model building code organizations and standards-setting groups, and thus will diffuse widely into the building practices of the United States.

Significant corollary products of this activity are expected. Principal among them will be an engineering applications handbook with refined costs data; a somewhat similar handbook for the use of decision makers at the local government level; a plan for a structured transfer of the technology embodied in the Guidelines using advanced dissemination media; and an identification of the most urgent research and development needs.

Federal buildings

In compliance with a US Congressional mandate contained in Public Law 101-614, a set of technical criteria with commentary was developed by the Interagency Committee on Seismic Safety in Construction, with management and funding by FEMA. The criteria provide federal agencies with minimum life safety standards for both the seismic evaluation and the

seismic rehabilitation of buildings in their inventories. To promulgate the standards, an Executive Order was also prepared.

The Order (No. 12941) was signed by the President on 1 December 1994. In addition to promulgation of the standards, it initiates a modest program of seismic rehabilitation in Executive Branch owned and leased buildings by requiring that the new standards must be applied in five specified conditions, or ‘triggers’. One such condition, and probably the most significant of the five, is a normal upgrading or rehabilitation of a federally owned or leased building costing more than 50% of the replacement value of that building. The Order also requires federal agencies to maintain an inventory of their owned and leased building stock and develop data on the cost of seismically rehabilitating it. These data will be the basis for the preparation by FEMA of a comprehensive long-term program to ensure the seismic safety of all owned and leased federal buildings that is due to the US Congress by 1 December 2000.

Guidance to the agencies as to how to proceed in the preparation of the required materials is under preparation by the Interagency Committee on Seismic Safety in Construction.

