August 2011

SeismicWaves

How the National Earthquake Hazards Reduction Program Is Advancing Earthquake Safety

A Major New E-Resource for Nonstructural Risk Reduction

"As advances are made in the structural design of buildings, and we experience fewer structural failures and fewer collapses as a result, the significance of nonstructural damage becomes more apparent."

"Nonstructural damage may account for more than 50% of total damage in future domestic earthquakes."[1]

The statements above reveal some of the impetus behind the development of an extensive new guide to mitigating nonstructural earthquake damage, *Reducing the Risks of Nonstructural Earthquake Damage—A Practical Guide* (Fourth Edition). Published early this year by the Federal Emergency Management Agency (FEMA) and known by its publication number, FEMA E-74, this 755-page resource updates guidance last issued in 1994.

FEMA contracted the Applied Technology Council (ATC) to prepare the guide. A team of experts was commissioned to review new knowledge generated in recent years by government, industry, and academia, and to synthesize this information into an updated document that is comprehensive and yet easy to navigate.

Understanding Nonstructural Risks

FEMA E-74 describes, in text suitable for both technical and non-technical readers, how nonstructural earthquake damage can occur and how it can be reduced. The content is applicable to a broad range of buildings, including schools, offices, stores, hospitals, hotels, and light manufacturing facilities, and the document is organized to serve the needs of a wide range of audiences, from those who own, manage, use, or maintain a single building to their counterparts in large multi-facility organizations.

Nonstructural components of buildings are categorized as architectural elements (such as interior partition walls, non-load-bearing exterior curtain walls, windows, and suspended ceilings); as mechanical, electrical, and plumbing (MEP) components (such as HVAC units, ducts, conduits, and pipes); or as furniture, fixtures, and equipment (FF&E) and other building contents. Collectively, these nonstructural components can account for as much as 80%–90% of the total cost of a new building.[2]

Earthquake ground shaking can damage nonstructural components by causing them to move, fall, or strike adjacent building elements. In addition, building sway can displace or deform structural elements such as columns and walls, damaging attached nonstructural items such as windows or curtain walls. The new guide explains these and other mechanisms through which earthquakes can damage nonstructural components, as well as the potential implications of such damage for the safety of building occupants, property losses, and building downtime or closures.

Reducing Nonstructural Risks

The bulk of FEMA E-74 consists of "component examples" for 72 different nonstructural components. Each example describes how one of the components can be damaged in an earthquake and how that damage can be

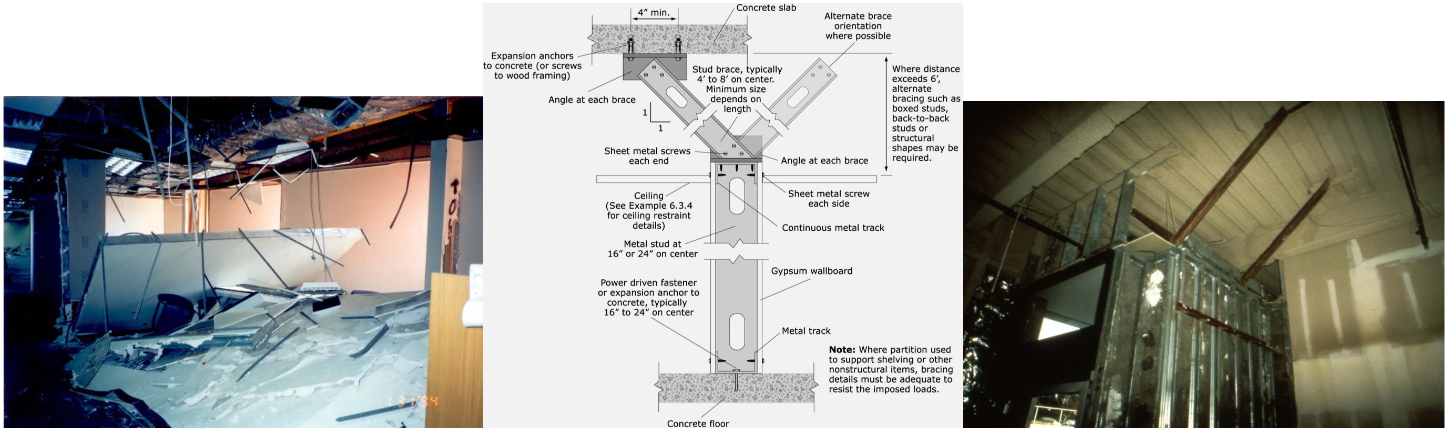
FEMA E-74 Product Availability

- FEMA E-74 is available on the FEMA website in HTML format for use online as well as in Adobe Portable Document Format (PDF) for downloading. These formats facilitate future document expansion and updating as well as user access and navigation.
  - ✓ Visit the online E-74 Table of Contents to view and print individual sections of the guide.
  - ✓ Download the guide in whole or in part from the FEMA Library.
- FEMA is developing two different training resources based upon the new guide: a 90-minute recorded presentation that will be available on the FEMA website, and instructor and student materials for a 4- or 5-hour live training class.
- Future plans call for a CD-ROM that will contain the PDF version of FEMA E-74 and the two training resources.
- FEMA is also about to issue a new contract under which ATC will again update FEMA E-74 to include new documentation from the recent Chile, New Zealand, and Japan earthquakes. This should result in an updated version of the guide by the end of 2012.

---

[1] ATC, *Reducing the Risks of Nonstructural Earthquake Damage—A Practical Guide*, FEMA E-74. (Washington, DC: FEMA, 2011), p. 4-2.

[2] Derived from FEMA E-74, Figure 2.1.3-1, p. 2-6.



Photos and illustration from the light interior partition wall component example in FEMA E-74. Left photo (courtesy of Wiss, Janney, Elstner Associates) shows failure of inadequately braced partial height partitions in the 1994 Northridge earthquake. Center detail illustrates seismic mitigation solution for nonstructural, partial height stud wall. Photo on right (courtesy of Degenkolb Engineers) shows appropriately braced partial height stud partition.

mitigated. The examples include information about the typical causes of damage to the component, accompanied by photographs of such damage from earthquakes over the past 40 years. This is followed by information about how to mitigate the damage, accompanied by detailed illustrations or photographs of anchoring, bracing, or other protective solutions commonly used for the component. Two-letter codes indicate whether the solution can be implemented by a handyperson or maintenance personnel, is likely to require a contractor, or should be designed by an engineer. The examples are grouped into subcategories under the main categories described above (architectural, MEP, FF&E and contents). Each example can be individually downloaded from the online version of the guide.

FEMA E-74 discusses a number of factors that should be considered in determining whether and how to mitigate potential nonstructural damage in new and existing buildings. Before beginning nonstructural risk reduction efforts, it is important to clarify their objectives by considering how the facility is or will be used, the user's tolerance for property losses and building downtime, the level of seismic hazard at the facility site, and the level of nonstructural seismic performance desired by the owner. Although it is generally more efficient and less costly to mitigate nonstructural components when a building is constructed and initially occupied rather than to upgrade these components in existing buildings, different levels of nonstructural seismic performance may be appropriate in either setting.

Local building codes and standards can affect the amount of latitude that organizations have in mitigating nonstructural earthquake damage. Current codes generally do not require mitigation of nonstructural seismic vulnerabilities in existing buildings, unless other improvements trigger the nonstructural requirements applicable to new buildings. In new buildings, codes generally require mitigation sufficient to protect the safety of occupants, and depending on the type of facility and level of seismic hazard, may require more stringent levels of nonstructural risk reduction.

FEMA E-74 also explains how to survey the nonstructural elements of existing buildings to identify components that may be vulnerable to earthquake damage. Associated appendices provide an inventory form and nonstructural components checklist that can be used for such surveys, as well as information about the risks that vulnerable components of various types pose for safety, property losses, and building downtime. Alternative approaches for implementing nonstructural risk reduction programs are also discussed, such as integrating mitigation efforts into facility maintenance programs, remodeling projects, and purchasing policies. Related appendices include sample nonstructural specifications for use in future contracts and responsibility matrices that can be adapted for specific nonstructural projects.