

## **GLOBAL BLUEPRINTS FOR CHANGE**

**First Edition--Prepared in conjunction with the International Workshop on Disaster Reduction convened on August 19-22, 2001**

The Global Blueprints for Change contain guidance for working together to improve the capability to identify indicators of physical, social, enterprise, and environmental vulnerabilities throughout the world and to select and implement realistic solutions to reduce them towards acceptable levels.

**Theme A: LIVING WITH NATURAL AND TECHNOLOGICAL HAZARDS**  
**Topic A.2: Reducing Vulnerabilities in Existing Buildings and Lifelines [with Consideration of Social and Environmental Factors]**

**“Notes on Overcoming the Barriers to Reduction of Vulnerability”**

**This contribution was created by James Beavers,  
Mid America Earthquake Research Center  
Champaign-Urbana, Illinois  
USA**

**DISCLAIMER:** This manuscript was prepared as a contribution to the first edition of the Global Blueprints for Change and for use in conjunction with the International Workshop on Disaster Reduction convened on 19-22 August 2001 in Reston, VA. The manuscript is a "work in progress" and has not been edited for policy and for conformity with the other Blueprints.

# NOTES ON OVERCOMING THE BARRIERS TO REDUCTION OF VULNERABILITY

James Beavers<sup>1</sup>

**Abstract:** On the basis of experiences in the United States gained through ongoing national programs on natural and technological hazards (which are summarized in the book, "**Disasters by Design**") and the experiences of others such as Munich Re (which are summarized in the publication, "**Topics 2000**"), we now have a good working knowledge of the causes of vulnerability in the built environment as well as effective ways to eliminate or reduce them. We believe that significant progress can be made by implementing basic actions aimed at reducing vulnerabilities in the roof, building envelope, structural, and foundation systems of a building to the specific disaster agents generated by the natural hazard.

## Background

The primary concern in the United States is the vulnerability of the huge and rapidly growing inventory that exceeds 100 million residential and commercial buildings and the vast infrastructure of lifeline systems performing the essential services of supply, disposal, transportation, and communication. The aggregate value of the residential and commercial buildings is increasing annually, reaching many trillions of dollars now. Many of these structures have vulnerabilities in their roof systems, building envelopes, structural systems, or foundation systems, which make them susceptible to damage from the disaster agents generated by hurricanes, other severe windstorms, earthquakes, floods, wildfire, hail, and winter storms. As we increase our understanding of these vulnerabilities, over time, we are able to pin down the level of susceptibility of individual residential and commercial structures to damage, loss of function, business interruption, and collapse when subjected to the disaster agents generated in hurricanes, other severe windstorms,

Experience has shown that the insured losses in residential and commercial buildings will occur primarily as a consequence of vulnerabilities in the roof, building envelope, structural, and foundation systems to the disaster agents generated by the specific peril or natural hazard. Damage to non-structural elements of the dwelling or commercial building and business interruption are also major sources of economic loss.

## Recommendations

We recommend the following actions:

1. Implementation of a set of holistic solutions that will reduce the recurring losses from severe windstorms, earthquakes, floods, hail, wildfire, and winter storms within a framework of social, technical, administrative, political, legal, educational, and economic considerations.

---

<sup>1</sup> Mid America Earthquake Research Center, Champaign-Urbana, Illinois, USA

2. Analysis of the causes of recurring damage to residential and commercial buildings from severe windstorms, earthquakes, floods, hail, wildfire, and winter storms.
3. Identification and characterization of the vulnerabilities (i.e., the actual and perceived weaknesses) in residential and commercial buildings and lifeline systems in terms of a specific architectural and/or structural system.
4. Ongoing dialogue on some of the current technological solutions being developed by researchers and applied by practitioners in an ongoing effort to reduce known vulnerabilities.
5. Ongoing evaluation of the promising new “works in progress” and prioritization of research and development activities to help speed delivery from researchers to practitioners of cost-effective technological solutions.

## **ANNEX I: EXAMPLES OF VULNERABILITIES IN A COMMUNITY’S BUILT ENVIRONMENT**

**Abstract:** Over the years, postearthquake studies have provided many important lessons on the societal impacts caused by the intersection of a community’s hazard, built, and policy environments. The primary lessons are: 1) Social and physical vulnerabilities are exposed in every damaging earthquake, 2) Physical vulnerabilities are caused by flaws in public policies that govern the planning, siting, design, construction, and use of buildings and infrastructure, 3) The performance of engineered buildings and infrastructure in earthquakes is linked to the effectiveness of the public process underpinning the adoption and enforcement of building codes and lifeline standards. 4) Engineered buildings and infrastructure typically perform much better than non-engineered buildings and infrastructure, and 5) 4) Buildings are more susceptible than buried infrastructure to damage from ground shaking, and buried infrastructure is more susceptible than buildings to damage from permanent ground deformation caused by surface fault rupture, liquefaction, lateral spreading, and landslides.

### **1.1 Introduction**

This annex describes the **built environment**, which encompasses the inventory of existing and new **buildings and infrastructure** of a community. It introduces the concept of **physical and social vulnerability**. Existing buildings and infrastructure represent approximately 95-98 percent of the total inventory at risk at any given time in a typical community, with residences, commercial buildings, and government buildings typically representing, respectively, approximately forty-four percent, thirty-two percent, and 10 percent of the community's inventory.

Every nation’s inventory is valued in the hundreds of billions to tens of trillions of dollars and is continuing to increase in value over time through the ongoing process of urban development, which adds many dollars per year in new value. The term infrastructure refers to the community’s lifeline systems constructed over time to provide the populace with the essential

functions of supply, disposal, transportation, and communication. Each element of the built environment has a specific function and service life, and is at risk to the physical effects of ground shaking, ground failure, surface fault rupture, tsunami flood wave run up, regional tectonic deformation, seiche, and aftershocks.

## **1.2 Elements of a Community's Built Environment**

A community's inventory of existing buildings typically includes:

- Single family dwellings.
- Multiple-family buildings.
- Low-rise office and commercial buildings.
- High-rise residential buildings.
- High-rise commercial buildings.
- Historic buildings.
- Industrial facilities and factories.
- Government buildings and facilities.
- Schools.
- Universities.
- Hospitals.
- Churches.
- Nursing homes.
- Day care centers
- Shopping malls
- Parking structures.
- Theaters.
- Sports arenas and stadiums.

The inventory of existing infrastructure typically includes:

- Highways.
- Bridges.
- Utilities (i.e., gas electricity, water, wastewater, and telephone).
- Tunnels.
- Railways.
- Subways.
- Water transport systems.
- Telecommunication systems.
- Waterways, ports, and harbors.
- Dams and levees.
- Fossil fuel and nuclear power plants.
- Storage tanks for water and hazardous materials.
- Airports.

## **1.3 Variability in a Community's Built Environment**

The building stock and infrastructure of a community are characterized by their variability. For example, individual buildings and infrastructure exhibit:

- Varying engineering design, ranging from non-engineered (e.g., a single-family dwelling) to engineered (e.g., a high-rise building) to very sophisticated engineering (e.g., a hospital or a nuclear power plant).
- Varying ages of construction.
- Varying service lives.
- Varying construction materials (e.g., wood, unreinforced masonry, unreinforced concrete, reinforced concrete, light metal, and steel).
- Varying functions during their useful service life (e.g., the functions represented by single family dwellings, multiple family dwellings, high-rise buildings, government centers, commercial buildings, industrial facilities, schools, hospitals, and places of public assembly).
- Varying levels of population density based on public and private use.

#### 1.4 What Makes a Community Vulnerable to Earthquakes?

No community in the world has “zero unacceptable earthquake risk.” A community’s proneness to unacceptable risk and **vulnerability** to earthquake ground shaking and ground failure are the result of flaws in planning, siting, design, construction, and ultimate use. The following kinds of vulnerabilities on the community’s built environment (i.e., buildings and community infrastructure, or lifeline systems) increase the likelihood for an earthquake disaster:

- Older residential and commercial buildings and infrastructure constructed of unreinforced masonry (i.e., URM’s) or any other construction materials having inadequate resistance to lateral forces of ground shaking, or if they were built to seismic codes and standards that are now considered by engineers to be out of date and inadequate.
- Older non-engineered residential and commercial buildings that have no lateral resistance, and are vulnerable to fire following an earthquake.
- New buildings and infrastructure that have not been sited designed, and constructed with adequate enforcement of modern, state-of-the-art building regulations, lifeline standards, and land use ordinances.
- Buildings and lifeline systems sited in close proximity to an active fault system, or on poor soils that either enhances ground shaking (e.g. soil amplification) or fails through permanent displacements (e.g., liquefaction and landslides), or in low lying or coastal areas subject either to seiches or tsunami flood waves.
- Modern buildings of poor design and construction quality.
- Schools and other buildings that have been built to low construction standards.
- Communication and emergency control centers that are concentrated in a high-hazard location.
- Hospital facilities that are inadequate and unprepared for large numbers of casualties and injuries.
- Bridges and viaducts that are elevated, have outdated design, and are likely to collapse or be rendered unusable by ground shaking.

- Electrical, gas, and water supply lines that are likely to be knocked out of service by permanent displacement ground failure (i.e., liquefaction, lateral spreads, and landslides).

## 1.5 Performance of Engineered Buildings in Earthquakes

Observations of the nature, degree, and spatial distribution of damage in past earthquakes have provided considerable data, insights, and case histories on building performance, physical vulnerability, and social vulnerability. These studies have shown that:

- Unreinforced masonry buildings are more vulnerable to collapse than buildings constructed from other types of building materials.
- Engineered buildings are not likely to collapse in a major earthquake.
- The poor, elderly, and disadvantaged are more likely to live in the most vulnerable buildings.
- Buildings constructed in accordance with modern building codes perform well in earthquakes.
- Buildings are more susceptible than infrastructure to damage from the lateral forces of ground shaking.
- The performance of specific building types in an earthquake can be used as a guide for improving risk assessments and risk management (i.e., mitigation and preparedness).
- The new knowledge and lessons gained from past earthquakes can be used as a basis for public policies on mitigation and preparedness to reduce potential losses from ground shaking, ground failure, surface fault rupture, regional tectonic deformation, tsunami wave run up, and the aftershocks.

Building codes are minimum standards, but they ensure a certain quality of construction and performance when enforced. Life safety is the fundamental premise on which all building codes are based. After life safety, the priorities are control of performance, control of damage to building elements, and long-term sustainability. Building codes are maturing rapidly now, and performance standards are emerging as a new technology. A building code contains technical prescriptions that integrate the amplitude, frequency composition, and duration of the ground motion expected at the site with the building materials to create lateral-force-resisting systems. The prescriptive forces used in design are based on experience in earthquakes and are a function of local construction conditions, building materials, and the tradeoffs in the stiffness, strength, ductility, and flexibility of the structural systems that resist the lateral forces.

Buildings are not designed to resist the actual lateral force levels generated by ground shaking for good economic reasons. Economic considerations make it impractical to design buildings for the actual lateral force levels that would be developed if the building response remained elastic throughout the ground shaking. Building codes prescribe design forces that are reduced to take advantage of the beneficial aspects of the energy absorption or inelastic deformation properties of different kinds of construction materials and the building's lateral-force-resisting systems.

**Every community has schools, hospitals, evacuation centers, government crisis command centers, emergency services centers, relief agency's centers, storage of hazardous materials, and other facilities. Each type of facility requires special considerations in their siting, design, and construction. State and local governments through explicit building**

**regulations and land-use ordinances typically address these special considerations.**

## **1.6 Performance of Engineered Infrastructure in Earthquakes**

Engineering practices to ensure the earthquake resistance of infrastructure systems that provide the essential services of supply, disposal, transportation, and communication are maturing rapidly now. Although the importance of community infrastructure to a community's welfare has long been recognized and acknowledged, it was not until after the 1971 San Fernando, CA earthquake and studies of other damaging earthquakes throughout the world in the 1980's and 1990's that professionals in the United States began to understand the factors that increase the vulnerabilities of infrastructure. Observations of the nature, degree, and spatial distribution of damage to infrastructure in past earthquakes have provided valuable data and insights on performance. These studies have shown that:

- Engineered infrastructure is less likely than non-engineered infrastructure to undergo serious failure in a major earthquake.
- Infrastructure constructed in accordance with rapidly evolving, modern lifeline standards maintain their performance better than non-engineered infrastructure in earthquakes.
- Underground infrastructure faces a problem generally not considered in building codes; namely, the high relative degree of their vulnerability to surface fault rupture and ground failure hazards. Past earthquake experience with underground lifeline systems indicates that underground components such as pipelines, vaults, underground storage tanks, and wells are much more vulnerable to ground failure hazards than to strong ground shaking. For example, ductile pipelines are able to resist the vibratory effects from earthquakes with little or no damage. However, when permanent displacements on the order of several feet (a meter or more) are imposed on these pipelines from fault rupture and/or severe liquefaction and landslide, severe buckling and/or rupture occur.
- Utility outages (i.e., power, gas, water, sewage, and telephone) that extend over long periods of time are the most disruptive socially.
- Loss of very small portions of a highway system (e.g., a single span of a bridge) can disrupt the normal functions of a community for long periods of time, delaying emergency response, and recovery and reconstruction.
- The performance of specific infrastructure systems in an earthquake can be used as a guide for improving risk assessments and management.
- Because of the significant vulnerability of underground infrastructure to ground failure hazards, a risk assessment methodology for lifelines must be able to predict both the likelihood and severity of ground failure for the entire lifeline system.
- Unlike buildings, lifeline systems are distributed over large geographic areas. Therefore, current probabilistic ground shaking hazard maps have two major shortcomings when used in earthquake disaster scenarios.

## **1.7 Social and Physical Vulnerability**

Postearthquake studies have shown that the destructiveness of an earthquake correlates directly with the social and physical vulnerabilities of a community. The lessons show that:

- Social and physical vulnerability exist in every community and in every nation, causing each citizen, and each building and infrastructure element in a community to be susceptible to mortality, morbidity, damage, and collapse or failure at some level of ground shaking or ground failure.
- The factors that influence and exacerbate social vulnerability include:
  - Social stratification.
  - Affordability of earthquake-resistant housing.
  - Availability and affordability of earthquake insurance.
  - Age, ethnic, cultural, age, and gender diversity.
  - Regional, national, and global economics.
  - Unavailability of technology.
  - Political arrangements.
- Physical vulnerability, the potential loss in value of each physical element of a community's built environment when subjected to earthquake hazards, is a result of flaws in planning, siting, design, construction, and use. The physical effects of an earthquake expose these flaws. For example,
  - The magnitude of the earthquake exposes the structures whose design underestimated the severity of ground shaking.
  - The proximity of the causative fault to the built environment of a community exposes the structures whose design underestimated the severity of ground shaking.
  - A shallow focal depth exposes the structures whose design underestimated the severity of ground shaking.
  - The directivity of the fault rupture exposes the structures whose design underestimated the severity of ground shaking.
  - Soil amplification caused by the geometry and physical properties of the near-surface soil and rock underlying the structure, exposes the structures whose design underestimated the severity of ground shaking.
- Well-known flaws in planning, siting, design, construction, and use of the built environment increase the vulnerability of buildings and infrastructure to ground shaking and ground failure. The most common flaws are:
  - Underestimation of the strength, duration, and frequency composition of the lateral forces of ground shaking, which are more destructive than the vertical forces.
  - Lack of consideration of the effects of soil amplification and topography on ground motion. Soils and topographic highs and lows have a period-dependent effect on the ground motion, increasing the level of shaking for certain periods of vibration and decreasing it for others as a function of the "softness" and thickness of the soil and the three-dimensional properties of the topographic feature or basin.
  - Inadequate consideration of the potential for soil/structure resonance, a condition of increased destructiveness that results when the input seismic waves cause the underlying soil and the structure to vibrate at the same period with very high amplitudes.
  - Lack of consideration of the increased destructiveness that results when the earthquake source has geometrical features that can increase the level of ground shaking, such as: a)

an anomalously shallow depth of focus, b) source directivity, the directional aspects of the fault rupture that cause more energy to be released in a particular direction instead of all directions, and c) the rupturing fault breaks the surface of the ground, instead of remaining buried below the ground surface.

- Ignoring the potential for and underestimating the damage potential of long-duration acceleration pulses generated close to the fault (i.e., the "killer pulse").
- Siting structures on water saturated sand deposits or on unstable soils that will undergo liquefaction, lateral spreading, or permanent, inelastic deformation when subjected to ground shaking.
- Introducing asymmetry, irregularity, and horizontal and vertical discontinuities in mass, strength, and stiffness in buildings and above ground infrastructure as they are designed and constructed, instead of using plans and elevations that have symmetry, regularity, and continuity.

### **Generic References (A partial list)**

Building Seismic Safety Council, NEHRP Recommended Provisions for Seismic Design, (New edition issued every three years), (1997)

Central United States Earthquake Consortium, Mitigation of Damage to the Built Environment: Monograph no. 2, Memphis, TN, 125 p. (1993).

Duke, C. M., and Moran, D. F., Earthquakes and City Lifelines, San Fernando Earthquake of February 9, 1971 and Public Policy, Joint Committee on Seismic Safety of the California Legislature, pp. 53-67. (1972).

Earthquake Engineering Research Institute, Bridging the Future: A New Generation of Codes, Standards, and Earthquake Engineering Professionals, 1999 Annual Meeting, Proceedings, Oakland, California, 68 p. (1999).

Earthquake Engineering Research Institute, Lessons Learned Over Time: Innovative Earthquake Recovery in India` Learning From Earthquakes Series, v. 11, Oakland, CA., 95 p. (1999).

Earthquake Engineering Research Institute, Postearthquake Investigation Field Guide, Publication 96-1, Oakland, CA, 114 p, (1996).

Englekirk and Hart Consulting Engineers. Typical Costs for Seismic Rehabilitation of Existing Buildings, Second Edition, 2 volumes, Publications 156 and 157. Washington, D.C.: FEMA. (1993).

Federal Emergency Management Agency, Plan for Developing and Adopting Seismic Design Guidelines and Standards for Lifelines, FEMA 271, Washington, D.C., 200 p. (1995).

Key, David, Earthquake Design Practice for Buildings: Thomas Telford Limited, London, 218 p. (1988).

Milliman, Jerome W., Modeling Regional Economic Impacts of Earthquakes. In Social and Economic Aspects of Earthquakes: Proceedings of the Third International Conference Held in Bled, Yugoslavia, edited by Barclay G. Jones and Miha Tomazevic. (1982).

National Research Council Committee on Earthquake Engineering. The Economic Consequences of a Catastrophic Earthquake. Washington, D.C.: National Academy Press. (1992).

Office of Science and Technology Policy, Construction and Building, Report of Subcommittee on Construction and Building, National Institute of Standards and Technology, Washington, D. C., 36 p. (1999).

Schiff, Anshel J., (Editor), Guide to Improved Earthquake Performance of Electric Power Systems, American Society of Civil Engineers, Technical Council on Lifeline Earthquake Engineering, Manual of Engineering Practice 96, 368 p, (1996).

Schiff, Anshel J., (Editor), Guide to Postearthquake Investigations of Lifelines, American Society of Civil Engineers, Technical Council on Lifeline Earthquake Engineering, Monograph 3, 267 p. (1991).

VSP Associates. A Benefit-Cost Model for the Seismic Rehabilitation of Hazardous Buildings, 2 volumes, Publications 227 and 228. Washington, D.C.: FEMA. (1991).

Weber, Stephen F. Cost Impact of the NEHRP Recommended Provisions on the Design and Construction of Buildings. In Societal Implications: Selected Readings, FEMA Publication 84. Washington, D.C., (1985).

### **Building Performance in Earthquakes**

Arnold, Christopher, and Michael Durkin, Hospitals and the San Fernando Earthquake of 1971: The Operational Experience. San Mateo, California: Building Systems Development, Inc. (1983).

Arnold, Christopher, Michael Durkin, Richard Eisner, and Dianne Whitaker. Imperial County Services Building: Occupant Behavior and Operational Consequences as a Result of the 1979 Imperial Valley Earthquake. San Mateo, California: Building Systems Development, Inc. (1982).

Earthquake Engineering Research Institute. The 1985 Mexico Earthquake. Earthquake Spectra, (1988).

Earthquake Engineering Research Institute. The Whittier Narrows Earthquake of October 1, 1987, Earthquake Spectra, V. 4., (1988).

Earthquake Engineering Research Institute, Reducing Earthquake Hazards: Lessons Learned from Earthquakes. El Cerrito, California, (1986).

Earthquake Engineering Research Institute. Loma Prieta Earthquake Reconnaissance Report, Earthquake Spectra, Supplement to V. 6, (1990).

Earthquake Engineering Research Institute, Northridge Earthquake of January 17, 1994.” *Earthquake Spectra*, Supplement C to Vol. 11, (1995).

Lew, H. S., (Editor), Performance of Structures During the Loma Prieta Earthquake of October 17, 1989, National Institute of Standards and Technology Special Publication 778. Washington, D.C.: U.S. Government Printing Office (1990).

### **Seismic Design Information for Architects and Engineers**

Arnold, Christopher, and Robert Reitherman, Building Configuration and Seismic Design. New York: John Wiley and Sons, 178 p.(1982).

Building Seismic Safety Council. Guide to Application of the 1991 NEHRP Recommended Provisions in Earthquake-Resistant Design of Buildings, FEMA Publication 140. Washington, D.C., (1995).

Building Seismic Safety Council, Seismic Considerations for Communities at Risk, Revised Edition, FEMA Publication 83. Washington, D.C. (1995).

Building Seismic Safety Council, Seismic Considerations: Apartment Buildings, Revised Edition, FEMA Publication 152, Washington, D.C., (1995).

Building Seismic Safety Council. Seismic Considerations: Elementary and Secondary Schools, Revised Edition, FEMA Publication 149. Washington, D.C., (1990).

Building Seismic Safety Commission, Seismic Considerations: Health Care Facilities, Revised Edition, FEMA Publication 150, Washington, D.C., (1990).

Building Seismic Safety Council. Seismic Considerations: Hotels and Motels, Revised Edition, FEMA Publication 151. Washington, D.C., (1990).

Building Seismic Safety Council. Seismic Considerations: Office Buildings, Revised Edition, FEMA Publication 153, Washington, D.C.(1995).

Building Systems Development, Inc., Establishing Programs and Priorities for the Seismic Rehabilitation of Buildings, 2 volumes, FEMA Publications 173 and 174. Washington, D.C., (1989).

California Seismic Safety Commission, Turning Loss to Gain: The January 17, 1994, Northridge Earthquake. Sacramento, California, (1995).

Reitherman, Robert, Reducing the Risk of Nonstructural Earthquake Damage: A Practical Guide, FEMA Publication 74, Washington, D.C., (1994).

Stratta, James L., Manual of Seismic Design. Englewood, New Jersey: Prentice-Hall, (1986).

## **INTERNET RESOURCES**

### World Wide Web (WWW) Sites

<http://adder.colorado.edu/hazctr/Home.html> (be sure to spell "Home" with a capital "H")

The Natural Hazards Research and Applications Center's Home Page provides an introduction to the many programs and services provided by Hazards Center; current and back issues of the center's electronic newsletter, *Disaster Research*; our lists of hazard information sources and institutions, useful hazard periodicals, GIS hazard researchers, center publications, new books on hazards and disasters, upcoming hazards conference around the world; as well as an annotated inventory of other Internet resources.

<http://www.fema.gov/>

The Federal Emergency Management Agency's Home Page contains a lot of information (over 500 pages)-about the agency itself; current disaster situations; and disaster preparedness, response, recovery, and mitigation for families and businesses. The site includes dozens of hypertext links to other Internet resources via its Global Emergency Management Service (GEMS) page (<http://www.fema.gov/fema/gems.html>).

<http://www.ngdc.noaa.gov/seg/hazard/hazards.html>

The National Geophysical Data Center (NGDC) Natural Hazards Data Page includes databases, slide sets, and publications available from NGDC on geophysical hazards such as earthquakes, tsunamis, and volcanoes, as well as the *Natural Hazards Data Resources Directory* (<http://www.ngdc.noaa.gov/seg/hazard/resource/hazdir.html>), published jointly with the Natural Hazards Center in 1990.

<http://www.usgs.gov>

The U.S. Geological Survey Home Page contains much useful information, including a natural hazards page (<http://info.er.usgs.gov/research/environment/hazards/index.html>) that provides information on earthquakes, volcanoes, coastal erosion, hurricanes, floods, and radon hazards.

<http://www.fedworld.gov/>

FedWorld is designed to provide a window to virtually all U.S. federal information services, including those dealing with disasters. It lists all agency Internet servers, provides access to the National Technical Information Service and the numerous reports available from that agency, as well as and many other federal reports.

## **Gophers**

[nisee.ce.berkeley.edu/1](http://nisee.ce.berkeley.edu/1)

The Earthquake Information Gopher maintained by the National Information Service on Earthquake Engineering (NISEE) offers information on all aspects of earthquakes and earthquake engineering, other organizations involved in earthquake hazard mitigation, and links to many other interesting gopher sites.

[mceer.eng.buffalo.edu](http://mceer.eng.buffalo.edu)

The Multidisciplinary Center for Earthquake Engineering Research (MCEER) Gopher presents even more general earthquake and earthquake engineering information, a raft of downloadable information, and access to MCEER's QUAKELINE database.

## **Lists/Newsletters/Discussion Groups**

FEMA e-mail News Service

To subscribe, send the e-mail message "subscribe news" to [majordomo@fema.gov](mailto:majordomo@fema.gov).

