NEHRP Recommended Provisions: Instructional Materials (FEMA 451B)

- These instructional materials complement FEMA 451, *NEHRP Recommended Provisions: Design Examples*
- Needed are copies of FEMA 451 and FEMA 450, the 2003 *NEHRP Recommended Provisions for New Buildings and Other Structures (*Part 1, *Provisions,* and Part 2, *Commentary)*

FEMA 450 and 451

Single copies of both publications are available at no charge from the FEMA Publications Center at **1-800-480-2520**

(order by publication number)

Acknowledgments

- FEMA 451 and 451B were developed for FEMA by the Building Seismic Safety Council (BSSC) of the National Institute of Building Sciences (NIBS).
- The BSSC also manages development and updating of the *NEHRP Recommended Provisions*.
- For information about the BSSC and its member organizations or to download FEMA 451 and 451B, see

http://bssconline.org

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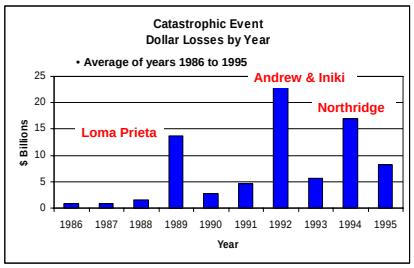
Motivation for Earthquake Engineering

- Minimize human death and injury
- Minimize economic loss
  - Direct (collapse and damage)
  - Indirect (loss of use, business interruption)
- Maintain lifelines

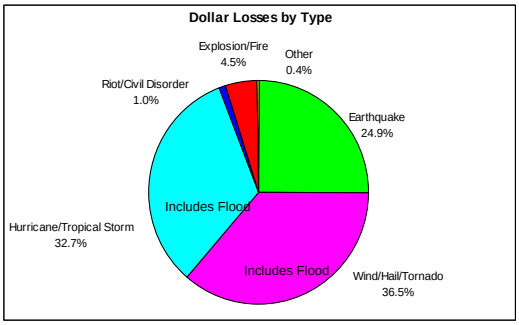
Losses Due to All Hazards



• Catastrophic event is defined as an event that has property loss claims in excess of $5 million.

Information provided by Property Claims Service

A Significant Portion of Dollar Loss Due to Earthquake



Examples of US Earthquake Losses

- 1906 San Francisco
- 1933 Long Beach
- 1964 Alaska
- 1971 San Fernando Valley
- 1989 Loma Prieta
- 1994 Northridge

1971 Earthquake in the San Fernando Valley of California

Earth dam located about 20 km from the epicenter. Part of the upstream face lost bearing strength and slipped beneath the water.

1971 San Fernando Valley Earthquake

"Soft story" failure of the Olive View Hospital. The column failure caused a collapse that pinned the ambulances under the rubble, rendering them useless.

1989 Earthquake in Loma Prieta, California

Oakland Bay Bridge failure.

1994 Earthquake in Northridge, California

Bull Creek Canyon Channel Bridge on the Simi Valley freeway near the epicenter to the north. Shear failure of a flared column.

1994 Northridge Earthquake

Gavin Canyon Undercrossing on I-5

Examples of Earthquake Losses Outside the United States

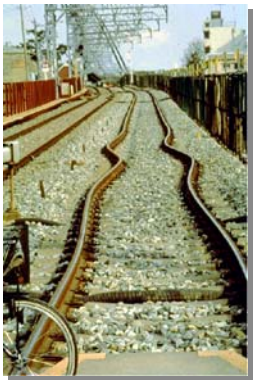
- 1923 Tokyo
- 1927 China
- 1985 Chile
- 1985 Mexico City
- 1988 Armenia
- 1993 Hokkaido
- 1995 Kobe
- 1999 Turkey, Taiwan
- 2001 India

1985 Mexico City Earthquake

Pino Suarez Towers looking north -- one of the few steel frame buildings to collapse.

1988 Leninakan, Armenia, Earthquake

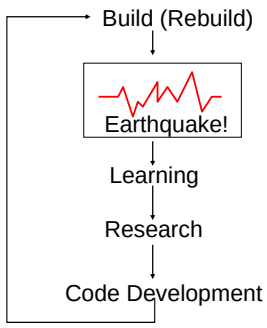
Damage to a stone bearing wall building. The floor planks were not tied to the supporting bearing walls.



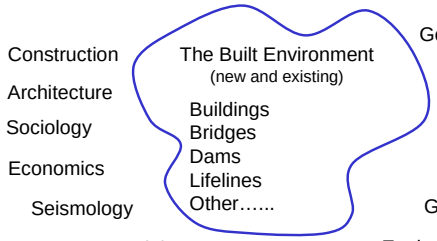
1995 Kobe, Japan, Earthquake

Distorted train tracks.

Typical Cycle



Who Is Involved in Earthquake Hazard Mitigation?



Construction
Architecture
Sociology
Economics
Seismology
Materials
Government
Insurance
Research
Education
Geology
Engineering

Hazard Risk Assessment

These Instructional Materials FOCUS on STRUCTURAL ENGINEERING and

- New buildings
- Hazards associated with ground shaking
- "Force-Based" approach of 2003 *NEHRP Recommended Provisions* (FEMA 450)
- Examples presented in *NEHRP Recommended Provisions: Design Examples* (FEMA 451)
- Probabilistic and deterministic based ground motions
- New concepts of performance-based engineering

Published Design Documents for New Buildings

- NEHRP Recommended Provisions (FEMA 450)
- IBC and IRC
- ASCE 7

1906 San Francisco Earthquake

2003 *NEHRP Recommended Provisions for New Buildings and Other Structures*

- Uses seismic hazard map (2%-50years) for evaluation purposes
- Relies on "equal displacement" concept to establish design forces
- Utilizes *linear elastic* static or dynamic analysis
- Deformations checked globally

Intended result (obtained somewhat *implicitly*):

- Little or no damage for frequent earthquakes
- Minor nonstructural damage for common earthquakes
- Life-safety or collapse prevention for rare earthquakes

Other Topics in this Series

Topic 1 Introduction to Course
Topic 2 Earthquakes Mechanics and Effects
Topic 3 Structural Dynamics of SDOF Systems
Topic 4 Structural Dynamics of MDOF Systems
Topic 5a Seismic Hazard Analysis
Topic 5b Ground Motion Maps
Topic 6 Inelastic Behavior of Materials and Structures
Topic 7 Concepts of Earthquake Engineering [FEMA 451, Ch. 1]
Topic 8a Introduction to the NEHRP [FEMA 451, Ch. 2]
Topic 8b Overview of Standards used in *NEHRP Recommended Provisions*
Topic 9 Seismic Load Analysis
Topic 10 Seismic Design of Structural Steel Structures [FEMA 451, Ch. 5]
Topic 11 Seismic Design of Reinforced Concrete Structures [FEMA 451, Ch. 6]
Topic 12 Seismic Design of Masonry Structures [FEMA 451, Ch. 9]
Topic 13 Seismic Design of Wood Structures [FEMA 451, Ch. 10]
Topic 14 Foundation Design [FEMA 451, Ch. 4]
Topic 16 Nonstructural Components [FEMA 451, Ch. 13]

Other Topics in this Series
Part 2: Advanced Topics

Topic 15-1	Introduction
Topic 15-2	Performance Based Engineering
Topic 15-3	Seismic Hazard Analysis
Topic 15-4	Geotechnical Earthquake Engineering
Topic 15-5a	Advanced Analysis, Part 1 of 3
Topic 15-5b	Advanced Analysis, Part 2 of 3
Topic 15-5c	Advanced Analysis, Part 3 of 3
Topic 15-6	Passive Energy Systems [FEMA 451, Ch. 6]
Topic 15-7	Seismic Isolation [FEMA 451, Ch. 11]
Topic 15-8	Nonbuilding Systems [FEMA 451, Ch. 12]

Chapters in the FEMA 451 Examples CD

Ch. 1	Fundamentals
Ch. 2	Guide to the Use of the *NEHRP Recommended Provisions*
Ch. 3	Structural Analysis (including nonlinear analysis)
Ch. 4	Foundation Design
Ch. 5	Steel Structures
Ch. 6	Reinforced Concrete Structures
Ch. 7	Precast Concrete Structures
Ch. 8	Composite Steel/Concrete Structures
Ch. 9	Masonry Structures
Ch. 10	Wood Structures
Ch. 11	Seismically Isolated Structures
Ch. 12	Nonbuilding Structures
Ch. 13	Nonstructural Components

Structural engineering:
The art of using materials that
have properties which can only be estimated
to build real structures that
can only be approximately analyzed
to withstand forces that
are not accurately known
so that our responsibility to the public safety is satisfied.