HANDOUTS:

a. U.S. Seismic Hazard Map (same as Overhead 3)
b. Historic Earthquakes in 36 States
c. MMI Scale (explanation, descriptions of effects of various MMIs)
d. Group Exercise #1 – Community Earthquake Risk
e. Purpose and History of Building Codes
f. Model Building Codes
g. Purpose of Seismic Code Provisions
h. Seismic Codes are Effective
i. Seismic Codes are Inexpensive
j. Group Exercise #2 – Responding to Arguments Against Seismic Codes
k. Arguments in Favor of Seismic Codes
l. Enforcing the Seismic Code: A Critical Link
m. Five Elements of Effective Code Enforcement
n. Group Exercise #3a – Action Plan for Adoption
o. Group Exercise #3b – Action Plan for Enforcement
p. Adopting Seismic Codes
q. Steps for Enforcement of Seismic Codes

Suggested handouts or overheads not included in this appendix:

1. Maps and images of historic *local* earthquakes, and, if maps are available, anticipated earthquakes. A good source of information is USGS Professional Paper 1527.
2. Consider handing out photocopies of Appendix D.
3. Develop a short questionnaire to solicit participant feedback.

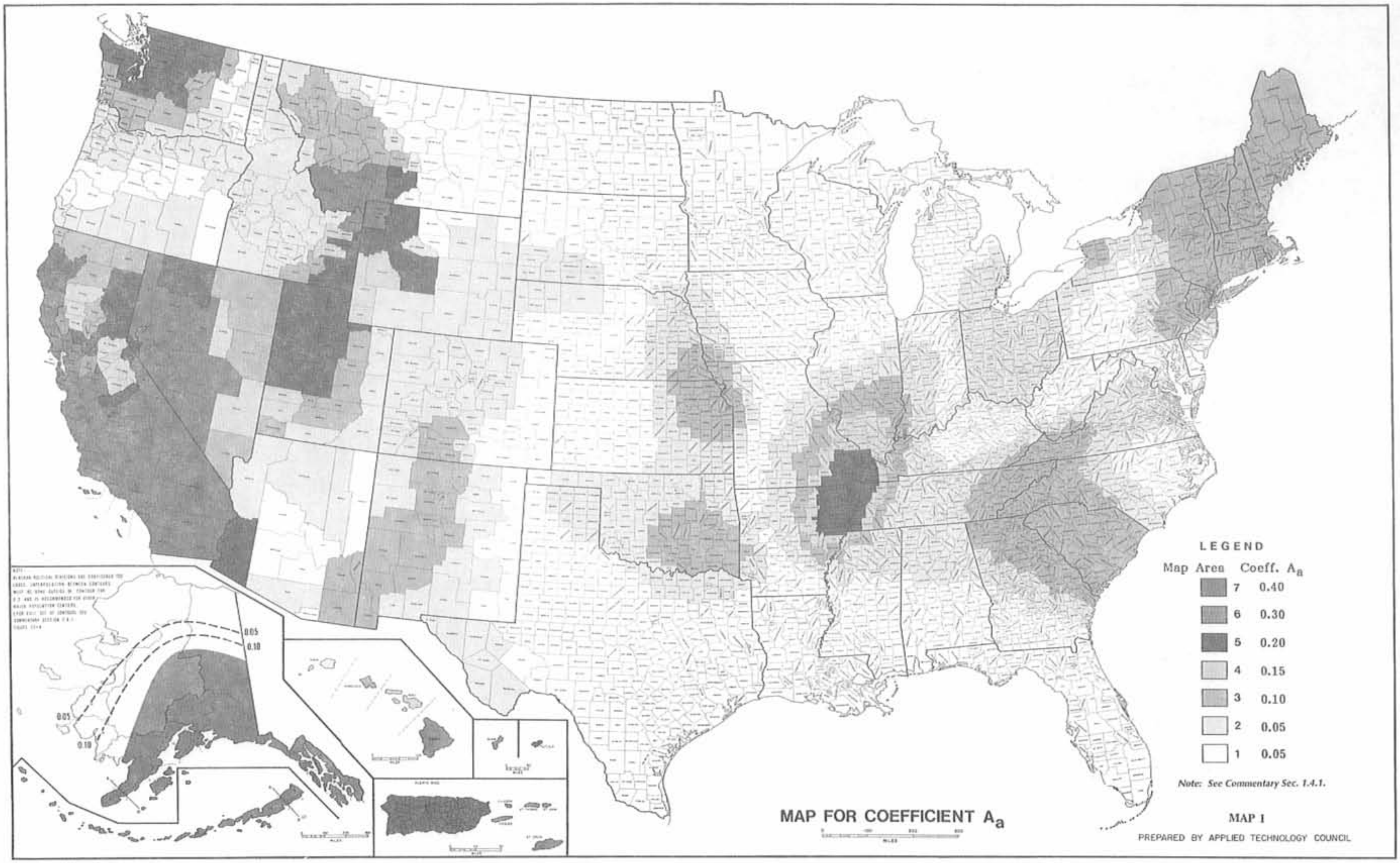
Three Main Areas Covered

1. ***Community risk for damage from earthquake activity***

2. ***Purpose of building codes, and how they help to protect the community from seismic risk***

3. ***Importance of following through by enforcing the building code, and how this too can benefit the community***

Seismic Hazard Map



Known Historic (1568-1989) Earthquakes in 47 States

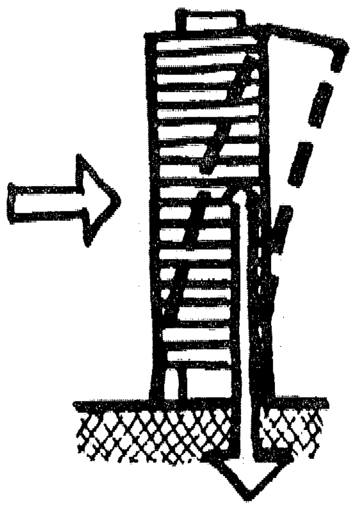
Number of Quakes With Reported Maximum MMI of:

State	VI	VII	VIII+
Alabama	5	7	
Alaska	41	21	13
Arizona	11	3	1
Arkansas	8	3	2
California	329	131	66
Colorado	19	2	—
Connecticut	2	1	—
Delaware	—	1	—
Florida	2	—	—
Georgia	5	—	—
Hawaii	30	13	10
Idaho	12	4	2
Illinois	18	12	—
Indiana	5	2	—
Kansas	4	2	—
Kentucky	8	1	—
Louisiana	1	—	—
Maine	7	2	—
Massachusetts	8	7	3
Michigan	1	1	1
Minnesota	3	—	—
Mississippi	2	—	—
Missouri	14	2	3
Montana	35	4	5
Nebraska	4	2	—
Nevada	28	10	8
New Hampshire	7	2	1
New Jersey	5	1	—
New Mexico	29	7	—
New York	16	6	2
North Carolina	5	2	—
North Dakota	1	—	—
Ohio	9	5	1
Oklahoma	9	2	—
Oregon	10	1	—
Pennsylvania	7	1	—
Rhode Island	1	—	—
South Carolina	17	2	1
South Dakota	6	—	—
Tennessee	12	2	—
Texas	7	1	—
Utah	31	8	5
Vermont	1	—	—
Virginia	12	1	1
Washington	37	6	3
West Virginia	1	—	—
Wyoming	8	1	—

Source: U.S. Geological Survey, Professional Paper 1527, 1993.

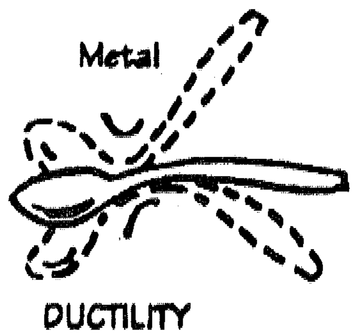
Note: This list includes only earthquakes that affected human settlements.

Seismic Design Concepts



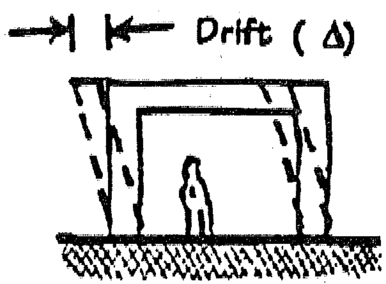
Lateral forces

Earthquakes exert sideways forces on buildings. Seismic design strengthens buildings to withstand lateral forces.



Ductility

This property allows structures to bend before they break. Seismic design makes buildings ductile to avoid catastrophic collapse.

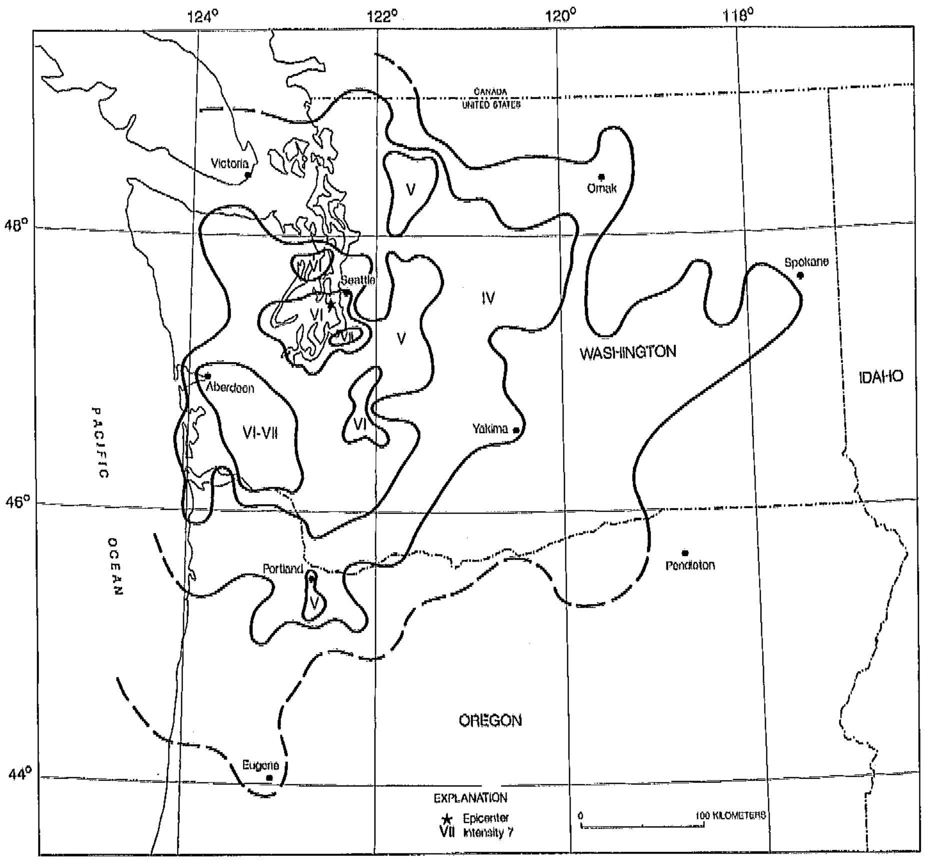


Drift

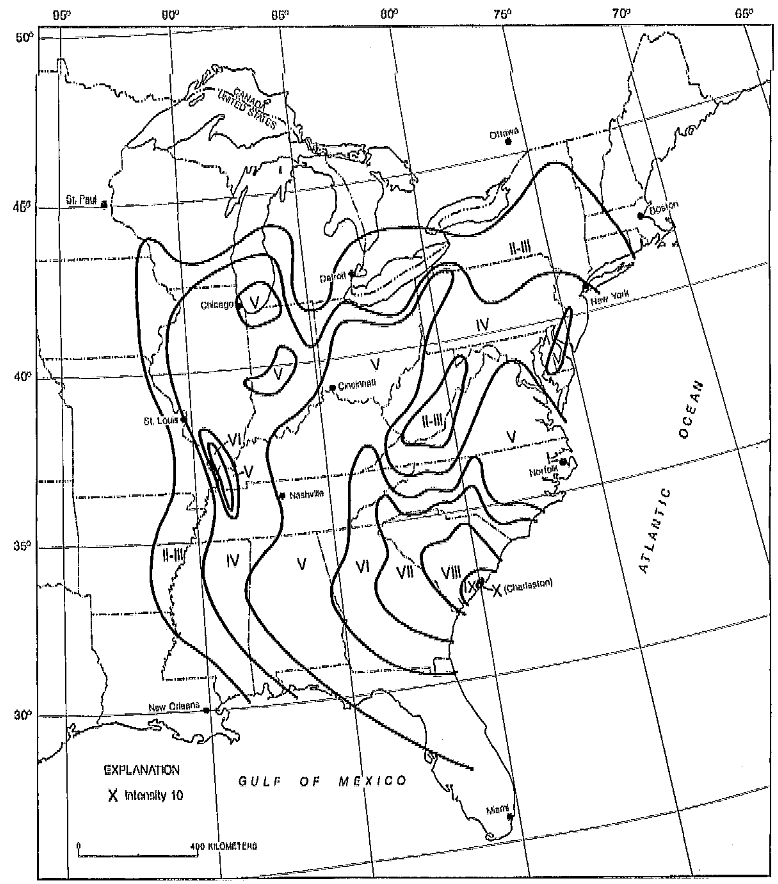
Structures can withstand sideways movement (drift), but their contents or neighboring buildings can be damaged. Seismic design limits drift.

Modified Mercalli Intensity Scale

The Modified Mercalli Intensity Scale is a qualitative scale that describes the effects of earthquake shaking. Because shaking decreases with distance from the center of an earthquake, the intensity also decreases with distance. Larger earthquakes have higher shaking intensity near the source, and shake a larger area.



Northwest Washington earthquake, Nov. 13, 1939.
(Maps: U.S. Geological Survey, Professional Paper 1527, 1993)



Charleston, South Carolina earthquake, Sept. 1, 1886

Overhead 5

Modified Mercalli Intensity Scale

The Modified Mercalli Intensity Scale is a qualitative scale that describes the effects of earthquake shaking.

Size of Earthquake (Magnitude)		Expected MMI	% Seismically Designed Buildings Damaged, According to Standardized Damage States				
			A	B	C	D	E
6.0-6.5	7.5-8.0		None	Slight	Moderate	Extensive	Complete
Distance to Fault							
30 mi.	50 mi.	VII	60-90%	10-40%	1-5%	<1%	0
5 mi.	40 mi.	VIII	35-60%	35-45%	10-30%	<5%	<1%
1 mi.	30 mi.	IX	25-40%	25-40%	20-40%	3-10%	<2%
-	3 mi.	X	5-25%	5-25%	40-70%	10-30%	<5%

Source: EERI Ad Hoc Committee

MMI – VI Effects

Felt by all people, indoors and out

People move about unsteadily

Some plaster cracks; fine cracks appear in chimneys

Dishes, glassware, and windows break

Books and pictures fall

Some furniture overturns

Objects fall from shelves

MMI – VII Effects

Most people are frightened, general alarm

Many people find it difficult to stand

Water is disturbed and muddied

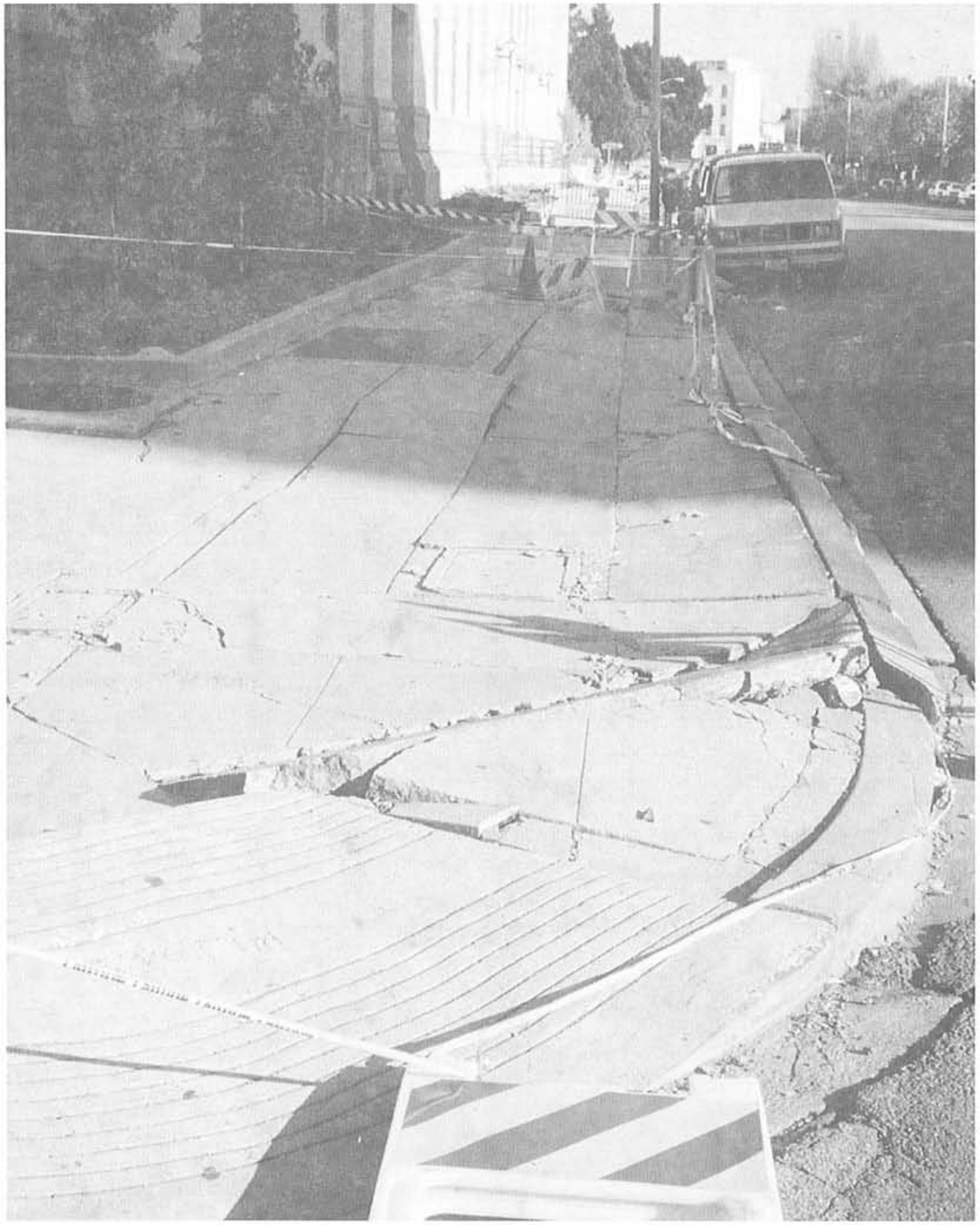
Some sand and gravel streambanks cave in

Chimneys crack to great extent; walls crack somewhat

Plaster and stucco fall in large amounts

Loosened bricks and tiles fall

Sidewalks crack



MMI – VIII Effects

Alarm approaches panic

People driving vehicles notice the disturbance

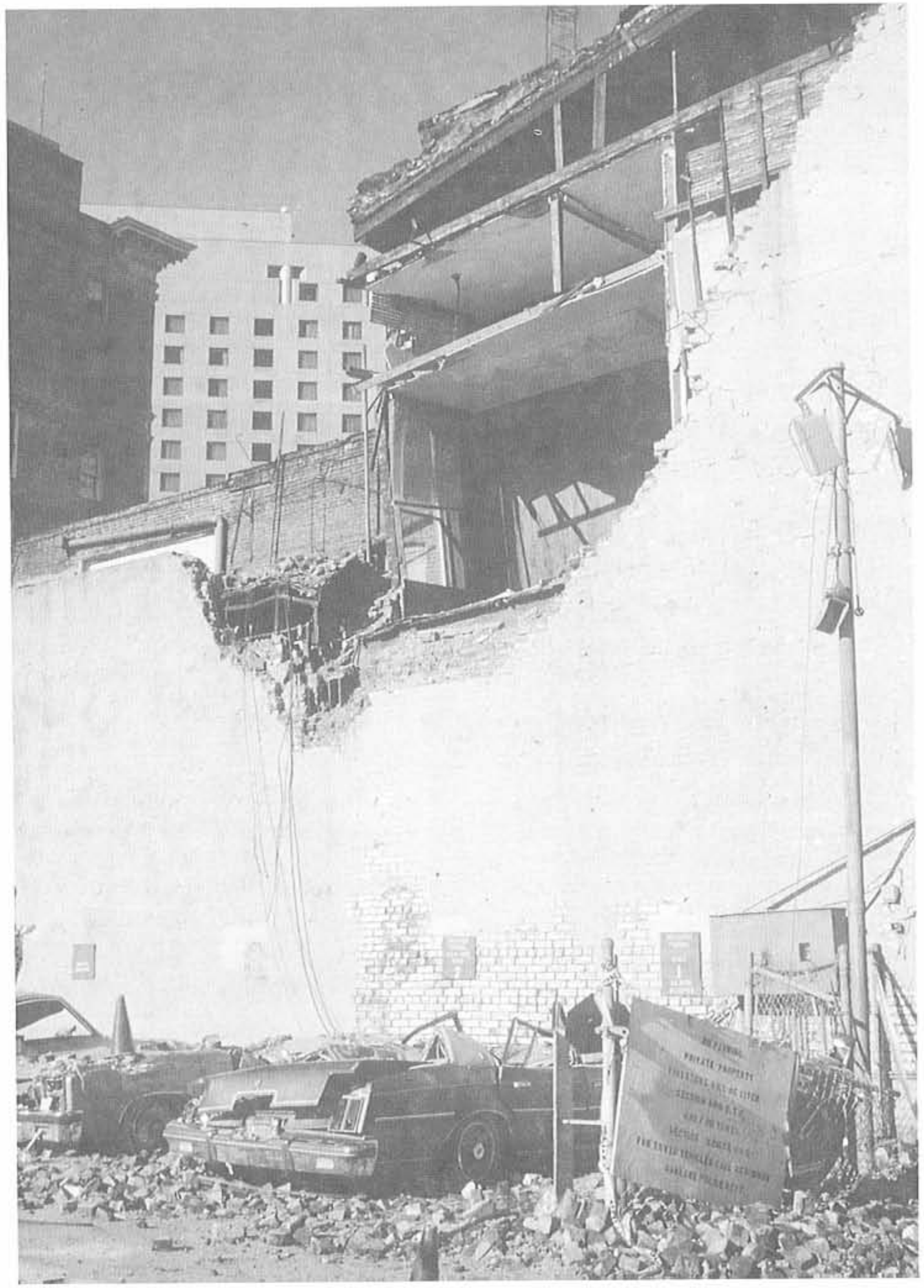
Trees shake strongly, and branches break off

Sand and mud are ejected from the ground in small amounts

Temporary and permanent changes occur in springs and wells

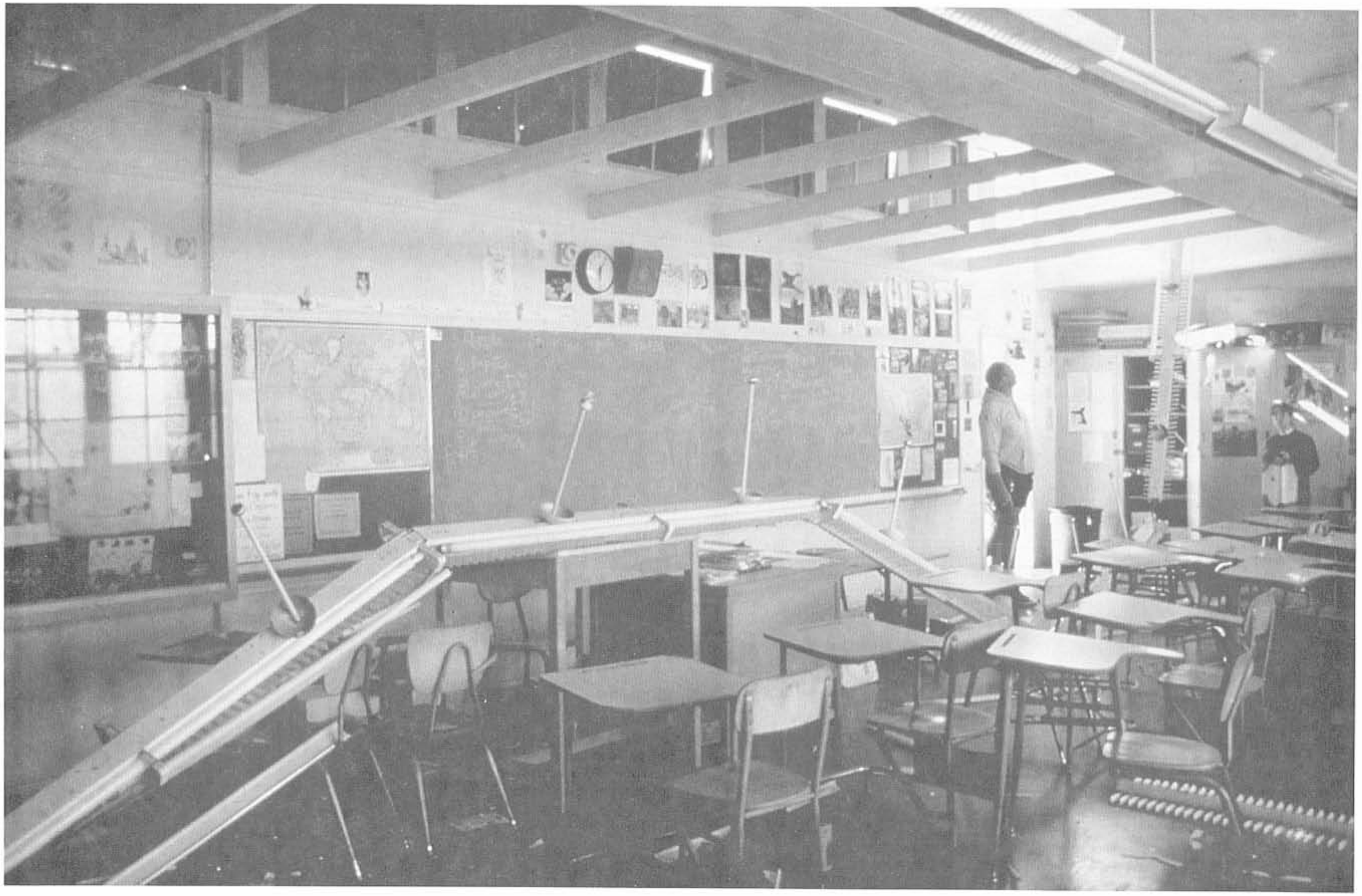
Chimneys, columns, monuments fall

Major structural damage can occur



MMI – VIII Damage

MMI – VIII Damage



MMI – VIII Damage

MMI – IX Effects

People generally panic

Ground cracks conspicuously

Masonry structures knocked out of plumb

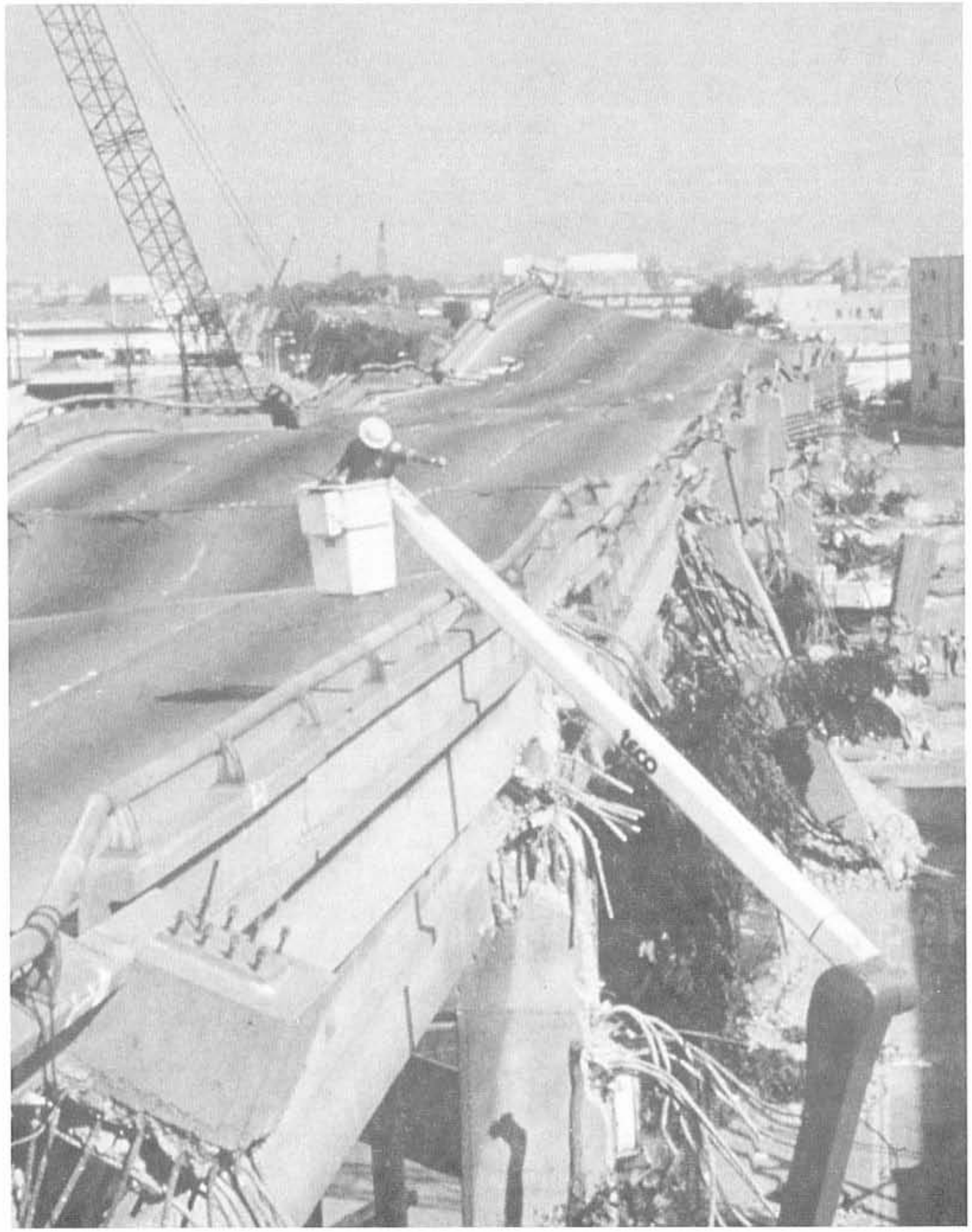
Large parts of masonry buildings collapse

Some buildings shift off of foundations and frames crack

Reservoirs are seriously damaged

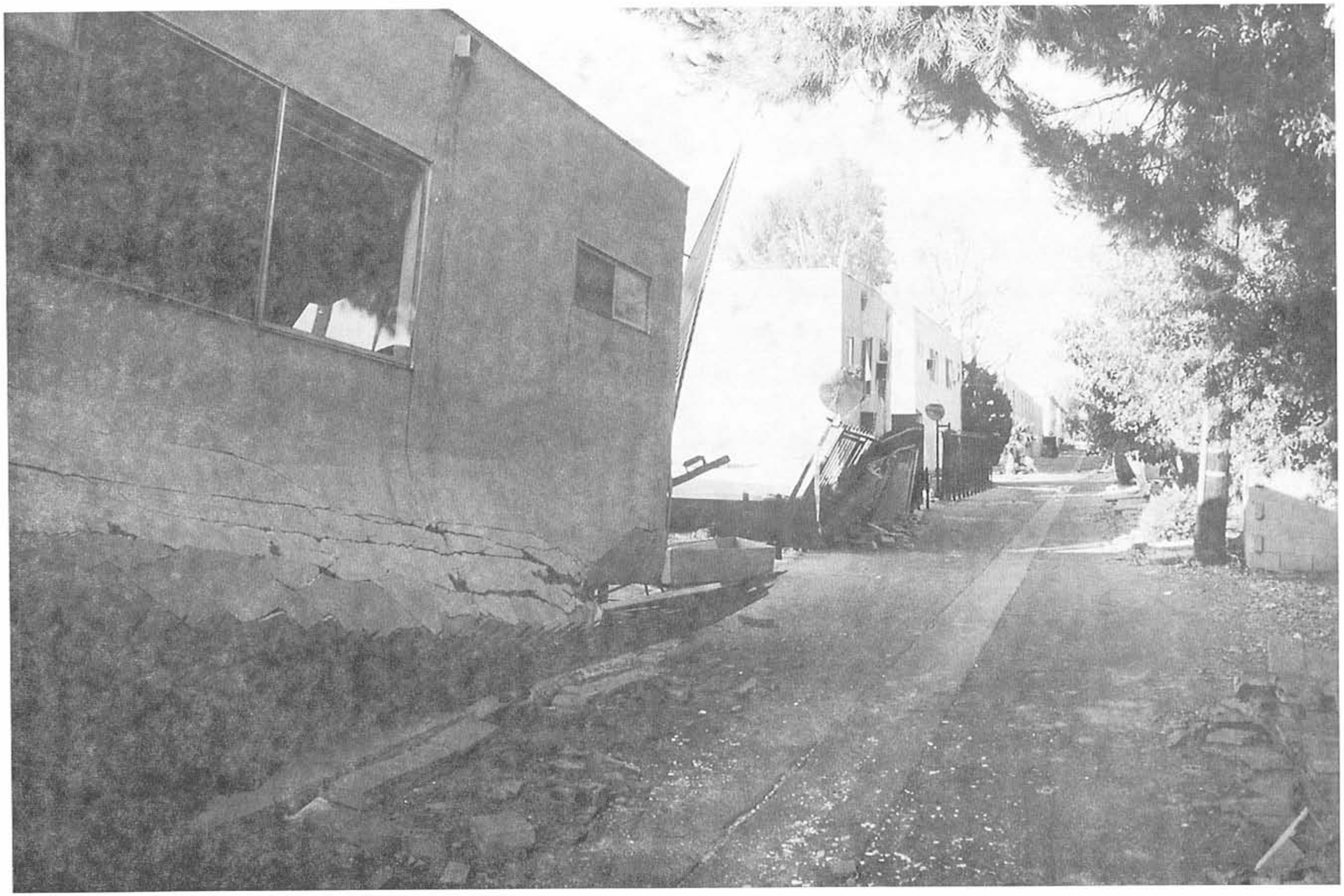
Some underground pipes break

Substantial buildings (and elevated freeways such as this) can collapse



MMI – IX Damage

MMI – IX Damage



Characteristics of Dangerous Buildings

- Brick or stone buildings
- Older buildings (especially large, multistory older buildings)
- Buildings with irregular shapes
- Buildings that appear to be top-heavy or with open first floors (carports, all windows)
- "Tilt-up" low-rise light industrial buildings (one-story warehouse-like buildings common in industrial or office parks since the 1960s).

Identifying Critical Structures

Critical structures are ones that would seriously affect the community if they collapsed or were severely damaged. Structures are deemed critical if they :

- **are needed immediately after an earthquake (fire and police stations)**
- **house needy populations (schools, hospitals, nursing homes)**
- **can have off-site effects (structures with flammable or toxic materials)**

Purpose and History of Building Codes

Building Codes Protect Public Safety

- Regulate building construction and use
- Address structural integrity, fire resistance, safe exits, lighting, and ventilation.
- Regulate construction materials
- Classify structures by use

Building Codes Have a Long History in the U.S.

- Have existed in North America since the seventeenth century
- Comprehensive building regulations were introduced in the mid-1800s
- The three model building codes used today were initiated between 1927 and 1950
- By 1960 more than 60% of American municipalities had adopted building codes
- By 1989 95% of American municipalities had adopted building codes

Model Building Codes

Building Officials and Code Administrators International, Inc. (BOCA)
- *Headquarters in Country Club Hills, Illinois*
- *Formed in 1915*
- *Code is titled the "BOCA National Building Code" (BNBC)*
- *Code is revised every three years*

International Conference of Building Officials (ICBO)
- *Headquarters in Whittier, California*
- *Formed in 1922*
- *Code is titled the "Uniform Building Code" (UBC)*
- *Code is updated every three years*

Southern Building Code Congress International, Inc. (SBCCI)
- *Headquarters in Birmingham, Alabama*
- *Founded in 1940*
- *Publishes the "Standard Building Code" (SBC)*
- *Code is updated every three years*

Council of American Building Officials (CABO)
- *Founded in 1972 by BOCA, ICBO, and SBCCI*
- *Publishes the One- and Two-Family Dwelling Code*

Purpose of Seismic Code Provisions

Structures built according to a seismic code should:

- ***Resist minor earthquakes undamaged***
- ***Resist moderate earthquakes without significant structural damage even though incurring nonstructural damage***
- ***Resist severe earthquakes without collapse, allowing safe evacuation of occupants***

Seismic Building Code Timeline

1905 Model building law published by NBFU

1906 San Francisco earthquake kills 3,000

1927 Uniform Building Code (UBC), with seismic provisions, first published by ICBO

1933 Long Beach earthquake kills 115

1935 Charles Richter devises magnitude scale for earthquakes

1940 Standard Building Code (SBS) published by SBCCI

1949 UBC contains first national seismic hazard map

1950 Basic Building Code (now the *BOCA National Building Code*) published by BOCA

1960 Sixty-percent of American municipalities had adopted one of the model codes

Early '70s Study of earthquake-resistant design provisions funded by NSF

1971 San Fernando earthquake kills 65

1972 CABO formed

1973 UBC revised because of San Fernando quake

1976 UBC includes new seismic provisions

1978 ATC releases ATC3-06 report

1979 BSSC formed

1985 FEMA releases NEHRP provisions for new buildings

1989 Ninety-five percent of American municipalities covered by state-wide codes

1989 Loma Prieta, California, earthquake kills 63

1990 EO 12699 requires that all federal agencies incorporate seismic resistant design in new buildings

1992 All three model codes require seismic designs consistent with NEHRP provisions

1992 Northridge, California, earthquake kills 57

1993 EO12699 provisions took effect

1994 ICC formed

1994 EO 12941 establishes seismic standards for federally owned or leased buildings

2000 ICC codes to be finished

Seismic Codes Are Effective

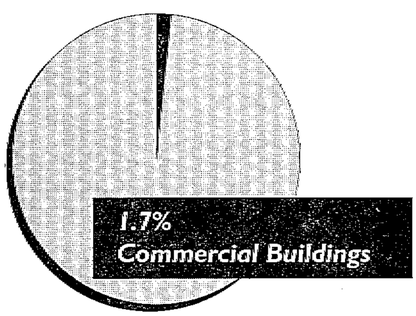
Ohbayashi Corporation's Study of Buildings Damaged in the January 17, 1995, Earthquake in Kobe, Japan*

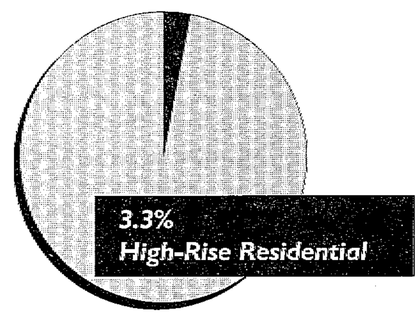
	Green Tags (little or no damage)	Yellow Tags (some damage)	Red Tags (extensive damage)
Pre-1971 Buildings (old seismic code)	42%	22%	36%
1972-1980 (transitional period)	72%	17%	11%
Post-1981 Buildings (new seismic code)	84%	10%	6%

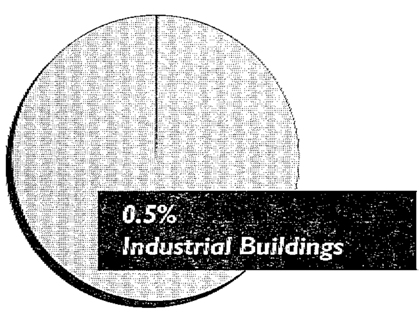
*In this study, Ohbayashi Corporation reviewed buildings it had constructed to the specifications of various seismic codes and assessed the extent of damage resulting from the 1995 earthquake.

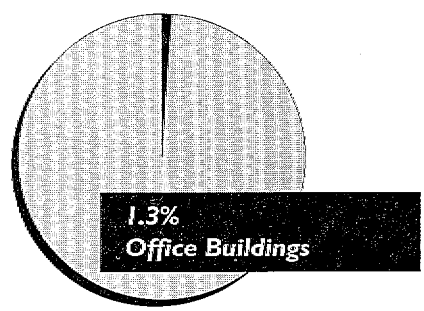
Seismic Codes Are Inexpensive

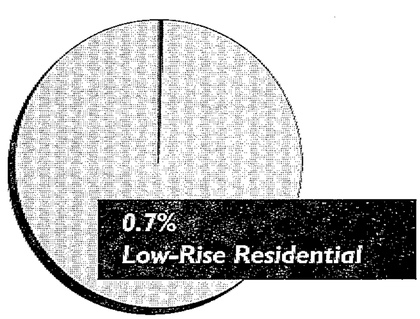
Increase in cost resulting from seismic design:











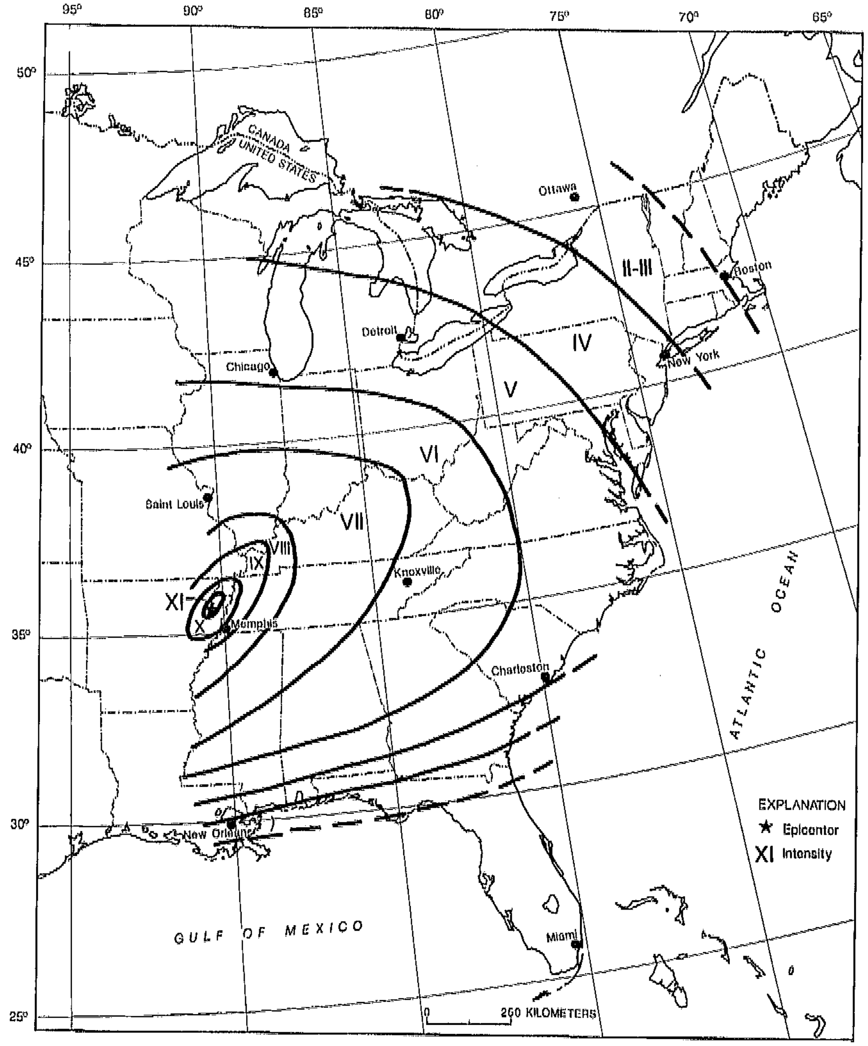
Source: Building Seismic Safety Council, 1985

Studies Indicate That the Benefits of Seismic Codes Outweigh the Costs

Estimated costs and benefits of seismic building codes for Memphis, Tennessee, assuming damage from magnitude 6 and 8 earthquakes in the southern New Madrid fault zone: benefits exceed costs by a factor of 1.8 for the magnitude 6 event and 10.3 for the magnitude 8 event.

The expected damage over forty years is more than three times greater than the costs of building to code.

Benefits are underestimated because they do not account for the benefits of reducing fatalities, injuries, fire potential, or economic losses.



New Madrid earthquake, Dec. 16, 1811. This was a magnitude 8 event. (Map: U.S. Geological Survey, Professional Paper 1527, 1993)

Arguments In Favor of Seismic Codes

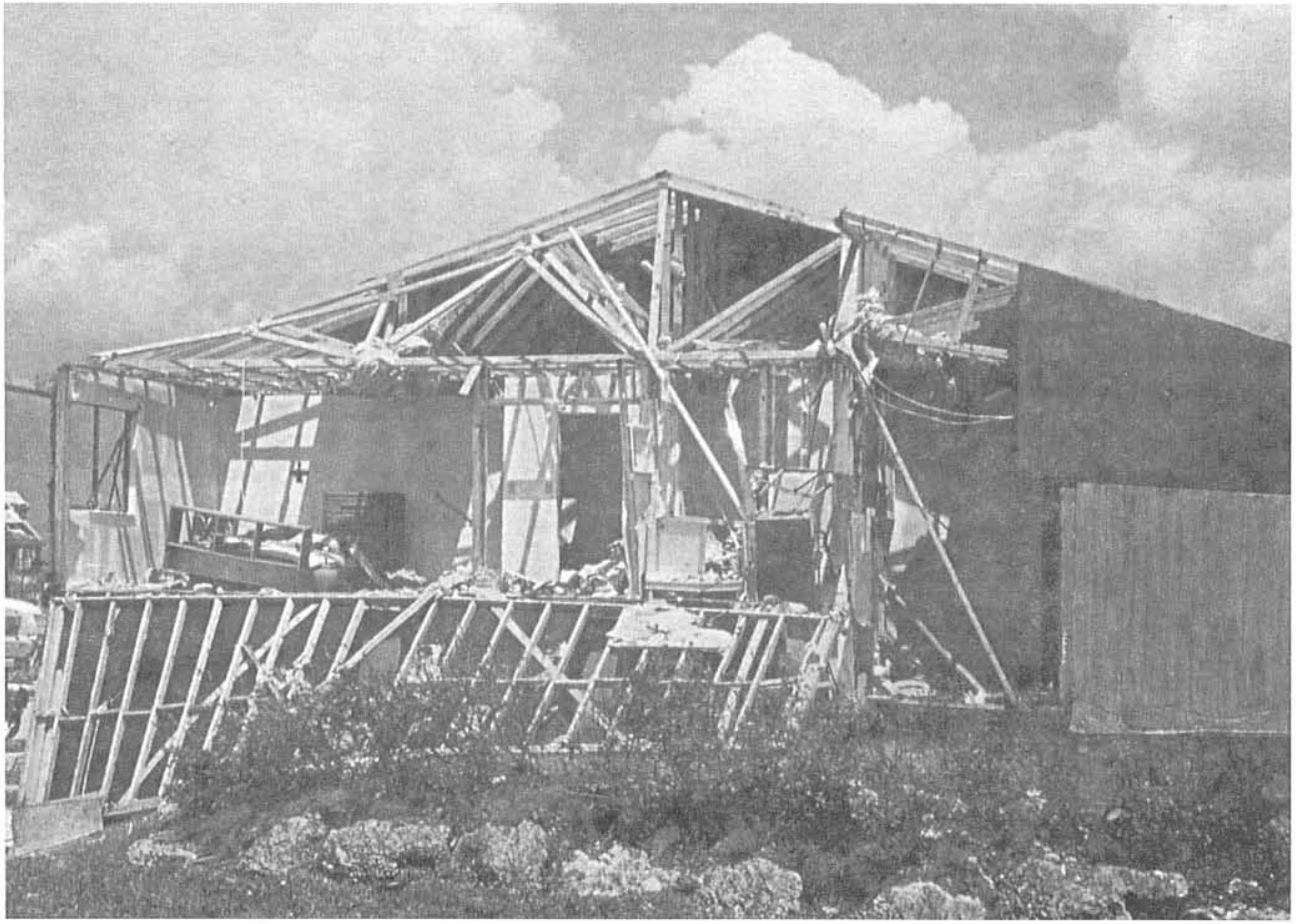
- *For elected officials: A damaging earthquake can occur during your term of office.*
- *For elected officials: Citizens support seismic codes.*
- *Codes will not hurt business.*
- *A seismic code will improve successful survival of the next earthquake.*
- *Everyone else is doing it.*
- *It's easy.*
- *It's good for the community.*
- *All communities need a seismic code regardless of risk.*

Poor Code Enforcement Results in Deficient Buildings

A substantial portion of the damage from Hurricane Andrew in 1992 was from lack of enforcement of the South Florida Building Code.

(Source: FEMA 1993)

In a 1993 study, USC researchers found that key items to resist seismic load are frequently (13 to 72 percent of surveyed units) missing or flawed.



Five Elements of Effective Code Enforcement:

1. Code provisions must be up to date

2. Builders must apply for permits

3. A qualified reviewer must review building plans

4. Construction should proceed according to approved plans

5. A qualified inspector must inspect the construction

Adopting Seismic Code Provisions

Step 1: Determine the current building code requirement (if any) and develop a strategy for incorporating or initiating current seismic provisions.

Step 2: Gather support for the proposed changes.

Step 3: Lobby the decision-making body with information explaining why the changes are needed and describing the kind of support you have gathered.

Step 4: Continue your involvement through the administrative implementation and enforcement stages once the seismic provisions are approved.

Establishing an Effective Building Code Enforcement Program

Step 1: ***Adopt a model code.***

Step 2: ***Establish fee structures for permits and plan review.***

Step 3: ***Institute a systematic plan review system.***

Step 4: ***Adopt an inspection schedule.***

Step 5: ***Maintain a trained, qualified staff.***

Step 6: ***Be persistent but patient.***

Some Selected Notable Earthquakes from 36 States

This table lists selected notable historical earthquakes from across the United States. Only states with at least one event of Modified Mercalli Intensity VII or greater are listed, and at least one such event is described for each state. Only a few illustrative events are listed for highly seismic states, such as California and Alaska. Note that this list is based on the location of the earthquake epicenter; many additional states have been affected by strong earthquakes in neighboring states.

This information is summarized from U.S. Geological Survey Professional Paper 1527, *Seismicity of the United States, 1568-1989* (rev.), 1993. This publication is a particularly good source of information for historic seismicity in all the states. It contains numerous maps of Modified Mercalli Intensities for historic earthquakes, including ones in your state. This publication can be purchased from the USGS at (800) 435-7627, or it can be obtained from most university or state geological survey libraries.

State	Date	Maximum MMI	Magnitude	Effects
AL	Oct. 18, 1916	VII	?	Destroyed numerous chimneys near Birmingham.
AK	July 10, 1958	XI	8.3	5 deaths, massive rockslide and ensuing wave, extensive damage to port facilities at Yakutat.
	March 28, 1964	X	9.2	125 deaths (110 from tsunami), $311 million in property loss. Heavy damage from building collapses and landslides in Anchorage; tsunami devastated many coastal areas.
AZ	May 3, 1887	XII	7.4	Centered in Northern Sonora, caused 51 deaths in Mexico, and widespread damage in southeast Arizona from intensities of VII, VIII, and IX.
AR	Dec. 16, 1811	XI	7.7	Part of New Madrid earthquake sequence, centered in northeast Arkansas. Extensive ground deformation and landsliding throughout sparsely-populated region. Chimneys toppled as far away as Cincinnati. Sequence includes the largest earthquakes known in 48 states.
	Jan. 1, 1969	VI	4.3	Walls and floors cracked and dishes broken in Little Rock.
CA	April 18, 1906	XI	7.7	Earthquake and fires killed 3,000 people and caused $524 million in property damage in and near San Francisco. Buildings and chimneys collapsed, pipelines broke, soft ground severely deformed. Fires destroyed a large part of San Francisco.
	March 11, 1933	VIII	6.2	115 people killed, $40 million in property damage. Severe property damage in Long Beach and Compton, particularly to masonry structures, especially those on soft ground.
	Feb. 9, 1971	XI	6.6	65 deaths, 2,000 injuries, and property damage of $505 million, mostly in San Fernando Valley. Damage to hospitals, freeways, utilities, dams. Older buildings and thousands of chimneys damaged. Fault rupture, ground fracturing, and landsliding caused extensive damage.
	May 2, 1983	VIII	6.2	Coalinga earthquake caused $10 million in property damage and injured 94 people. 8-block downtown area almost completely destroyed, primarily unreinforced brick buildings. Newer buildings sustained only superficial damage. Also destroyed hundreds of single-family homes and apartments.
	Oct. 17, 1989	IX	7.1	63 deaths, 3,757 injuries, and $6 billion in property damage. Damage to freeways and to older buildings on soft soils in San Francisco and Oakland. Severe damage in and near Santa Cruz, primarily to unreinforced brick buildings. Engineered buildings, including those near the epicenter, performed well.

Some Selected Notable Earthquakes from 36 States Continued

CO	Aug. 9, 1967	VII	5.3	Foundations, floors, and walls cracked, windows broke in northern suburbs of Denver.
	Nov. 8, 1882	VII	6.2	Minor damage in Colorado and southern Wyoming. Electricity cut off in Denver; plaster fell from the ceiling of a building at the University of Colorado in Boulder.
CT	May 16, 1791	VII	?	Stone walls shaken down, tops of chimneys fallen in Middlesex County, northeast of New Haven. Felt in Boston and New York.
DE	Oct. 9, 1871	VII	?	Chimneys toppled and windows broken in Wilmington area.
HI	Nov. 29, 1975	VIII	7.4	Two deaths, property damage of $4.1 million on island of Hawaii. Slight to moderate structural damage to 100 buildings from ground-shaking. Widespread ground deformation, subsidence, and faulting. Tsunami caused considerable damage to coastal areas.
ID	March 28, 1975	VIII	6.1	Shifted houses from foundations and toppled chimneys in sparsely-populated Pocatello Valley. Caused $1 million in damage.
	Oct. 28, 1983	IX	7.0	Two deaths and $12.5 million in damage in Challis-MacKay area. Numerous commercial buildings damaged, primarily those built of masonry. 90 percent of chimneys in Mackay were damaged. Extensive damage to high school in Challis.
IL	Nov. 9, 1968	VII	5.3	Cracked foundations, downed chimneys, broken windows in southern Illinois. Most buildings with chimney damage were 30 to 50 years old. Felt in parts of 23 states.
IN	Sept. 27, 1909	VII	5.1	Downed chimneys and cracked plaster in Terre Haute, Covington, and Princeton.
KS	Jan. 8, 1906	VII	4.9	Fallen chimneys and cracked plaster in and near Manhattan.
KY	July 27, 1980	VII	5.0	Caused $1 million damage in Maysville to 37 commercial and 269 residential structures. Old multistory brick structures in the downtown were affected the most. Fallen chimneys and cracked ground occurred. Felt in parts of 15 states.
ME	March 21, 1904	VII	5.1	Overthrew chimneys in Washington County. Felt throughout New England.
MA	Nov. 18, 1755	VIII	?	Up to 1,500 chimneys damaged in Boston, stone fences thrown down, ground cracking. Much of the damage in Boston was on filled land near wharfs. Generated a tsunami that affected the West Indies. Earthquake was centered off Cape Ann.
MI	July 27, 1905	VII	4.5	Downed many chimneys and broke plate glass windows at Calumet, Houghton County.
MO	Feb. 7, 1812	XII	7.9	Part of New Madrid earthquake sequence. Destroyed town of New Madrid. Many houses damaged in St. Louis. Ground warping, fissuring, landslides. Sequence includes the largest earthquakes known in 48 states.
	Oct. 31, 1895	VIII	6.7	Extensive damage to schools, churches, private houses, and almost all the buildings in the commercial section of Charleston. Extensive damage also to public buildings and brick walls in Cairo, Illinois. Felt in parts of 23 states.
MT	June 28, 1925	VIII	6.6	Severe damage to chimneys and schools in Gallatin County. Almost all masonry buildings showed damage.
	Oct. 18, 1935	VIII	6.2	This was the main shock in a series of at least three large earthquakes during October. These caused an estimated total of $4 million in property damage in Helena. Two people were killed and 300 buildings damaged. Damage was most severe to old brick houses. Downed chimneys and cracked plaster common. Severe damage to Helena High School (completed 2 months earlier) and other public buildings.

Some Selected Notable Earthquakes from 36 States Continued

	Aug. 18, 1959	X	7.3	28 deaths, and $11 million in damage to highways and timber. Most disastrous effect was from a huge landslide in the Madison River Canyon.
NE	Nov. 15, 1877	VII	5.1	Damaged courthouse and school at Columbus, cracked walls. Felt in seven states.
NV	Dec. 21, 1932	X	7.2	Major earthquake in an uninhabited region, as is true of most of Nevada's major historical earthquakes. Chimneys and walls fell in Mineral County. Large landslides occurred and boulders were shaken from cliffs.
NH	Dec. 20-24, 1940	VII	5.5	Two similarly-sized earthquakes damaged old houses and chimneys in Carroll County. Also cracked walls, broken pipes, and broken furniture. Minor damage in Maine, Massachusetts, New York, Vermont.
NJ	June 1, 1927	VII	?	Damage to chimneys and fallen plaster in Monmouth County.
NM	Jan. 23, 1966	VII	5.0	Damage to chimneys, brick walls, and plaster, especially at schools in Dulce. Rock falls at Dulce Point.
NY	Aug. 10, 1884	VII	5.5	Severe property damage at Jamaica and Amityville. Fallen chimneys and cracked walls throughout area.
	Sept. 5, 1944	VIII	5.5	Caused $2 million in property damage at Massena, NY, and Cornwall, Ontario. At Massena, 90% of chimneys were damaged, as were many house foundations, plumbing, and masonry. Chimneys were downed in several NY towns.
NC	Feb. 21, 1916	VII	5.2	Tops of chimneys and windows broken in Waynesville. Minor damage in wider area of NC and TN.
OH	March 9, 1937	VIII	5.4	Damaged almost every chimney in Anna (Shelby County), severely cracked the schoolhouse, and damaged two churches. Felt in tall buildings in Chicago, Milwaukee, and Toronto.
OK	April 9, 1952	VII	5.5	Toppled chimneys and smokestacks, loosened bricks, and broken windows at El Reno, Oklahoma City, and Ponca City. Caused 15-meter-long crack in State Capitol building.
OR	March 25, 1993	VII	5.6	Caused significant structural damage to many unreinforced brick buildings at Scotts Mills and Mollala. Estimated $2 million in uninsured losses, and $12 million damage to public facilities. Cracked State Capitol rotunda. (Source: EERI Newsletter, vol. 27, no. 5, 1993)
	July 16, 1936	VII	5.8	Chimneys broken, houses shifted from foundations in Umatilla County. Several houses severely damaged, school damaged. Caused $100,000 damage. Many ground cracks formed.
SC	Aug. 31, 1886	X	7.0	60 deaths, $5-6 million in damage. Most structures in Charleston were seriously damaged. Every brick and stone building was cracked. Large public buildings required extensive repair. 65% of brick buildings were damaged, compared to 7% of wooden buildings. Structural damage also in AL, OH, KY, VA, and WV. Extensive cratering and fissuring, severely damaged railroad tracks. (Source: O.W. Nuttli, G.A. Bollinger, R.B. Herrmann, *The 1886 Charleston, South Carolina, Earthquake—A 1986 Perspective*, U.S. Geological Survey Circular 985, 1986)
	Jan. 1, 1913	VII	4.8	Overthrew chimneys, damaged plaster and stone walls in Union County. Cracked walls of jail and courthouse in Union.
TN	Aug. 17, 1865	VII	5.0	Chimneys thrown down at Memphis, and chimneys damaged at New Madrid, MO. Felt from St. Louis to Jackson, MS.
TX	Aug. 16, 1931	VIII	5.8	All buildings except wood-frame houses were damaged in Valentine, and all chimneys were toppled or damaged. Schoolhouse had to be rebuilt. Landslides occurred in a widespread area.

Some Selected Notable Earthquakes from 36 States Continued

UT	March 12, 1934	VIII	6.5	In a sparsely-settled area in Box Elder County, but two people were killed. Downed chimneys and cracked walls in brick buildings. Large rockslides and fissures.
	Aug. 30, 1962	VII	5.8	Severely damaged many unreinforced brick buildings in Cache Valley. 75% of chimneys collapsed in Richmond, walls of many houses were badly damaged, and several houses were unsafe for occupancy. Property damage of $1 million. Landslides also occurred.
VA	May 31, 1897	VIII	5.6	Damaged chimneys and brick houses in Giles County, especially at Pearisburg. Large area felt Intensity VII, including Lynchburg, VA, Bluefield, WV, and Bristol, TN. Felt from Georgia to Pennsylvania.
WA	April 13, 1949	VIII	6.7	8 people killed, $25 million in property damage in Puget Sound area. Almost all large buildings were damaged in Olympia, including eight on the Capitol grounds. Several structures condemned, including three schools, a church, and a library. At Seattle, houses on filled ground were demolished, many old brick buildings were damaged and chimneys toppled.
	April 29, 1965	VIII	6.7	7 people killed, $12.5 million in property damage. In West Seattle, two schools were severely damaged and chimneys were damaged extensively. Unreinforced brick buildings were damaged most severely, and wood-frame buildings performed very well.
WY	June 30, 1975	VII	6.4	Caused rockfalls, landslides, and cracks in a parking lot at Yellowstone Park. Many park roads were closed. Two new geysers formed.
Guam	August 8, 1993	?	8.1	This very powerful earthquake was centered about 40 miles south of Agana. Generated no tsunamis, no deaths, and comparatively little damage to Guam's code-designed structures. The most significant damage occurred to some of the tall hotels, possibly due to construction quality problems. Significant ground failure problems occurred in waterfront areas. (Source: EERI Newsletter, vol. 27, No. 10, October 1993)

Effects of the most common damaging MMI intensity values

MMI Level	Effects
V	Felt by most people, indoors and out
	Buildings tremble
	Dishes and glassware break
	Small or unstable objects overturn and may fall
	Doors and shutters open or close abruptly
	Small objects and furnishings move slightly
	Liquids in open containers may spill slightly
VI	Felt by all people, indoors and out
	People move about unsteadily
	Some plaster cracks; fine cracks appear in chimneys
	Dishes, glassware, and windows break
	Books and picture fall
	Some furniture overturns
VII	Most people are frightened
	Many people find it difficult to stand
	Water is disturbed and muddied
	Some sand and gravel streambanks cave in
	Chimneys crack to great extent; walls crack somewhat
	Plaster and stucco fall in large amounts
	Loosened bricks and tiles fall
	Damage negligible in buildings of seismic design and construction
	Damage considerable in poorly built buildings
VIII	People are alarmed
	People driving vehicles notice the disturbance
	Trees shake strongly, and branches break off
	Sand and mud are ejected from the ground in small amounts
	Temporary and permanent changes occur in springs and wells

MMI Level	Effects
VIII	Ground becomes wet to some extent, even on steep slopes
	Chimneys, columns, monuments fall
	Damage slight in structures built to with-stand earthquakes
	Damage considerable in ordinary substantial buildings
IX	People generally panic Ground cracks conspicuously
	Masonry structures knocked out of plumb
	Large parts of masonry buildings collapse
	Some buildings shift off of foundations
	Reservoirs are seriously damaged
	Some underground pipes break
	Damage considerable in structures built to withstand earthquakes
	Damage great in substantial buildings
X	Ground cracks as large as several inches
	Numerous landslides on riverbanks and steep slopes
	Most masonry and frame structures are destroyed
	Buried pipelines are torn apart or crushed
	Wavy folds open in concrete pavements and asphalt surfaces

Group Exercise #1: Community Risk at MMI ____

SAFETY RATING SCALE					
Don't Know	Unsafe				Very Safe
?	1	2	3	4	5

	Safety Rating	Built to Current Building Code Specs? y/n/?	Built to Current Seismic Code Specs? y/n/?
City Hall Building:	____	____	____
Fire Station(s):			
____________	____	____	____
____________	____	____	____
School(s):			
____________	____	____	____
____________	____	____	____
____________	____	____	____
Hospital(s):			
____________	____	____	____
____________	____	____	____
Recent large building(s):			
____________	____	____	____
____________	____	____	____
Other major community building(s):			
____________	____	____	____
____________	____	____	____

Where would you like most to be during an earthquake?

____

____

____

Where would you like least to be during an earthquake?

____

____

____

Purpose and History of Building Codes

Building codes regulate building construction and use in order to protect the safety of occupants. Codes address structural integrity, fire resistance, safe exits, lighting, and ventilation. Codes also regulate construction materials.

Building codes classify structures by use and apply different standards to each classification. For example, office buildings and residential multi-unit buildings are in separate categories with different performance (such as strength and stability) requirements.

The validity of building codes is based on state police powers, which allow regulation of activities and property to preserve or promote the public health, safety, and general welfare. Zoning ordinances and environmental protection regulations are also founded in police powers.

Building Codes Have a Long History in the U.S.

Building codes to reduce the loss of life, limb, and property have existed in North America since the seventeenth century. The earliest building regulations addressed problems resulting from dense urban construction, such as rapid spread of fire. New York City, then called New Amsterdam, first regulated chimneys and roofing material in 1648. These regulations were aimed at controlling the destructive force of fire in urban areas, as evidenced by London's 1666 fire, New York's 1835 and 1845 fires, and the great Chicago fire of 1871.

Comprehensive building regulations were introduced in the mid-1800s. Building regulations were of two types: housing codes and building codes. Housing codes were intended to reduce the ill effects of residential overcrowding, and their introduction paralleled Europe's housing and sanitation reform. New York City in the late 1850s adopted a citywide housing code in order to provide air and light into dwellings and reduce the risk of fatal hazards. Chicago followed by passing its initial tenement housing ordinance in 1874. Building codes were later enacted to comprehensively specify construction methods and materials.

In 1905 the National Board of Fire Underwriters published a model building law aimed at reducing fire risks. The three model building codes used today were initiated between 1927 and 1940. The use of codes spread with the growth of new building across the country, particularly after World War II. By 1960 more than 60 percent of American municipalities had adopted building codes.

Model Building Codes

A model building code is a document containing standardized building requirements applicable throughout the United States. Model building codes are performance standards specifying the required performance of all structures. They are published by private organizations, whose voting members are government jurisdictions. The United States has three prominent model building code organizations: the International Conference of Building Officials (ICBO), which publishes the *Uniform Building Code* (UBC); the Building Officials and Code Administrators International, Inc. (BOCA), which publishes the *BOCA National Building Code* (BNBC); and the Southern Building Code Congress International, Inc. (SBCCI), which publishes the *Standard Building Code* (SBC). Each organization also publishes companion documents covering mechanical work, plumbing, fire protection, electrical work, energy, accessibility, and life safety codes.

In addition to writing and updating the codes, the organizations offer a variety of support services, including such technical services as training seminars, code interpretation, technical and administrative publications, customized consulting, videos, and software. Each organization offers certification programs to allow skilled inspectors and plan reviewers to be recognized for their levels of knowledge and experience. For example, BOCA offers certification by examination in twenty-two categories and ICBO in nineteen categories. SBCCI offers four levels of certification in various categories to encourage professional growth through progressive levels of certification.

The model building codes are revised periodically by a democratic process. Each organization allows the public to propose code amendments and hear testimony in meetings organized by the organization, so members and nonmembers are equal participants. Active members of each organization vote on revisions after final testimony is heard during their annual meeting. The content of the codes has become more similar over time, although they still address regional conditions and practices. The newest versions reflect a common code format so that similar topics can be found in consistently numbered chapters among the codes.

Although the code organizations have widespread membership, each organization's model building code is predominantly adopted in one portion of the United States. The BNBC is predominantly adopted in the northeast and north central states, the SBC predominates in the southern states east of the Mississippi, and the UBC is predominant in the western states, including Guam.

In addition, BOCA, ICBO, and SBCCI have moved forward on the development of a single model code, the International Building Code. On December 9, 1994, the International Code Council (ICC) was formed to develop a single set of comprehensive and coordinated national codes. The advantages of a single code are numerous. Code enforcement officials, architects, engineers, designers, and contractors can have consistent requirements that can be used across the country and around the world. Manufacturers can put their efforts into innovative products, instead of designing for all three regional codes. To date, the ICC has produced codes that address plumbing and private sewage disposal. The goal is for the complete family of international codes to be developed by the year 2000.

The ABCs of Model Building Codes

Building Officials and Code Administrators International, Inc. (BOCA). BOCA, headquartered in Country Club Hills, Illinois, was formed in 1915. Its first code, the Basic Building Code now titled the *BOCA National Building Code* (BNBC), was published in 1950 in an attempt to standardize existing codes. The BNBC is revised every three years, most recently in 1996, with a new edition due out in 1999.

International Conference of Building Officials (ICBO). ICBO was formed in 1922 to integrate various design requirements into one code. ICBO published its first model code, the *Uniform Building Code* (UBC), in 1927 from its headquarters in Whittier, California. ICBO updates the UBC every three years. The latest edition was published in 1994.

Southern Building Code Congress International, Inc. (SBCCI). The third model building code organization, the SBCCI was founded in 1940. Located in Birmingham, Alabama, it publishes the *Standard Building Code* (SBC). The SBC is updated every three years, most recently in 1994.

Council of American Building Officials (CABO). CABO was founded in 1972 by BOCA, ICBO, and SBCCI. The *One- and Two-Family Dwelling Code* applies to the construction, prefabrication, alteration, repair, use, occupancy, and maintenance of detached one- or two-family dwellings and one-family town houses not more than three stories in height.

Purpose of Seismic Code Provisions

Seismic Codes Are Designed to Help Buildings Resist Earthquake Shaking

It is important to understand that seismic codes result in earthquake-*resistant* buildings rather than earthquake-*proof* buildings. Their purpose is to protect life safety by preventing building collapse and allowing for safe evacuation. The contents and interiors of buildings, even those of well-designed buildings, may receive extensive damage, and entire functions of a building may cease. And structural damage may occur from major earthquake ground-shaking. According to the Structural Engineers Association of California, structures built according to a seismic code should:

- resist minor earthquakes undamaged,
- resist moderate earthquakes without significant structural damage even though incurring nonstructural damage, and
- resist severe earthquakes without collapse.

Occasionally even a code-designed building may collapse due to unique site conditions or other factors. A report completed by the Earthquake Engineering Research Institute (EERI) just prior to the Northridge, California, earthquake summarized expected earthquake damage to buildings designed according to the 1991 UBC. It stated, for example, that shaking of Intensity VIII could cause moderate damage (easily repairable) to 10 to 30 percent of code-designed buildings, and extensive damage (long-term closure, difficult to repair) to 0 to 5 percent of code-designed buildings. This was the intensity level experienced by much of the San Fernando Valley in January 1994, and buildings performed generally as expected.

Seismic Codes Reflect Social Judgments Regarding Acceptable Risk and Cost

Seismic design standards reflect society's balancing of the risks versus the costs of designing to withstand that risk. They do this in two ways: by designing for (a) an appropriate-sized event and (b) an appropriate performance goal. Society cannot justify the expense of designing for large but highly improbable events. So we select a ground motion event—called the *design event*—that although large and rare has a reasonable chance (10 percent) of being exceeded during a building's lifetime (50 years). The probability selected reflects society's attitude toward risk. This is similar to the philosophy long used for flood protection: Society is willing to absorb the cost of designing for a 100-year flood, but with the exception of critical facilities it would not make economic sense to design for the 500-year or 1,000-year flood.

The goal of seismic codes is to ensure that buildings will not collapse, thereby killing those inside, if shaken by the design event. Seismic codes are for "life safety" and are not aimed at completely preventing damage to existing buildings. Additionally, it is important to realize that there is a 10 percent chance of an earthquake occurring that exceeds the design event.

Seismic Codes Are Effective

Seismic Codes Are Effective

Experience with recent earthquakes in the United States and throughout the world shows that seismic codes work. Cities with seismic codes suffer much less damage than those without such codes.

The Loma Prieta earthquake clearly illustrates the effectiveness of seismic codes. Occurring on October 17, 1989, this earthquake measured 7.1 on the Richter scale and was the strongest in the United States since the 1964 Alaskan earthquake. It shook the San Francisco Bay Area and killed sixty-three people. Although the ground-shaking was intense within the metropolitan area, few buildings collapsed. Most of the damage occurred to unreinforced masonry buildings built before the adoption of seismic codes. Nearly all major reinforced concrete structures built after World War II survived without collapse. Even at the quake's epicenter new buildings and buildings located on firm ground suffered little damage. Informed observers attribute the success to the required UBC seismic codes. This example illustrates that code requirements reduced the damage and loss of life during this moderate earthquake.

A Kyoto University study of the 1995 earthquake in Kobe, Japan, Richter magnitude 6.9, found that damage to reinforced concrete buildings closely paralleled improvements to seismic provisions in the Japanese building code. More than 55 percent of pre-1970 buildings (old version of code) were severely damaged, compared with no post-1980 buildings (newest version of code). Results for steel buildings were comparable.

Even smaller earthquakes can cause extensive damage where buildings are not designed for seismic shaking. A Magnitude 5.6 earthquake in 1993 at Scotts Mills, Oregon, caused significant structural damage to a number of unreinforced masonry (brick) buildings in the area. A high school building was significantly damaged and vacated, 16 residences and 54 businesses sustained major damage, and the Oregon State Capitol, in Salem, suffered cracking in the rotunda. The estimated damage cost to public facilities alone was nearly $13 million. This earthquake confirmed the susceptibility of unreinforced buildings to severe damage, even in a minor earthquake.

Seismic Codes Are Inexpensive

Seismic codes add relatively little to the costs of a structure. To assess the costs of the *National Earthquake Hazard Reduction Program (NEHRP) Seismic Provisions*, the BSSC in 1985 contracted seventeen design firms from nine U.S. cities to perform two designs for each of several typical building types, first using the existing local code and then using the seismic provisions. They found the average increase in total costs to be 0.7 percent for low-rise residential buildings, 3.3 percent for high-rise residential buildings, 1.3 percent for office buildings, 0.5 percent for industrial buildings, and 1.7 percent for commercial buildings. Cities with previous seismic design provisions in their codes averaged much smaller cost increases (0.9 percent) than did cities with no seismic codes at all.

A 1992 study by the National Association of Home Builders (NAHB) for the Insurance Research Council examined the incremental costs of building single-family residences to 1991 *NEHRP Provisions*. They found that "builders can construct houses providing for life safety in earthquakes at a very reasonable added cost-less than 1 percent of the purchase price of a new home in most instances."

All Three Model Codes Contain Seismic Requirements Appropriate to the Community's Level of Risk

Each model code contains a seismic hazard map, based on current scientific knowledge. Its risk philosophy is accepted by a broad consensus of scientists and design and construction professionals. Its use in seismic design was determined by a nationwide consensus process conducted by the Building Seismic Safety Council (BSSC), an organization of more than fifty construction, professional, and trade organizations.

Portions of thirty-nine states are considered to have some degree of earthquake hazard. Some counties need to design for high levels of earthquake ground-shaking, whereas others should design for relatively less. Conversely, some areas, even those with seismic codes, do not need seismic design at all because the risks are so low.

Since 1992 all three model codes require seismic design standards consistent with the *NEHRP Provisions*. ICBO has long been a leader in seismic code development; BOCA incorporated the 1988 *NEHRP Provisions* into the 1992 BOCA *Supplement*; and SBCCI for the first time incorporated seismic design provisions in the 1992 amendments to the SBC. Thus, all communities **that adopt the most recent editions of these codes** have the most advanced seismic codes available.

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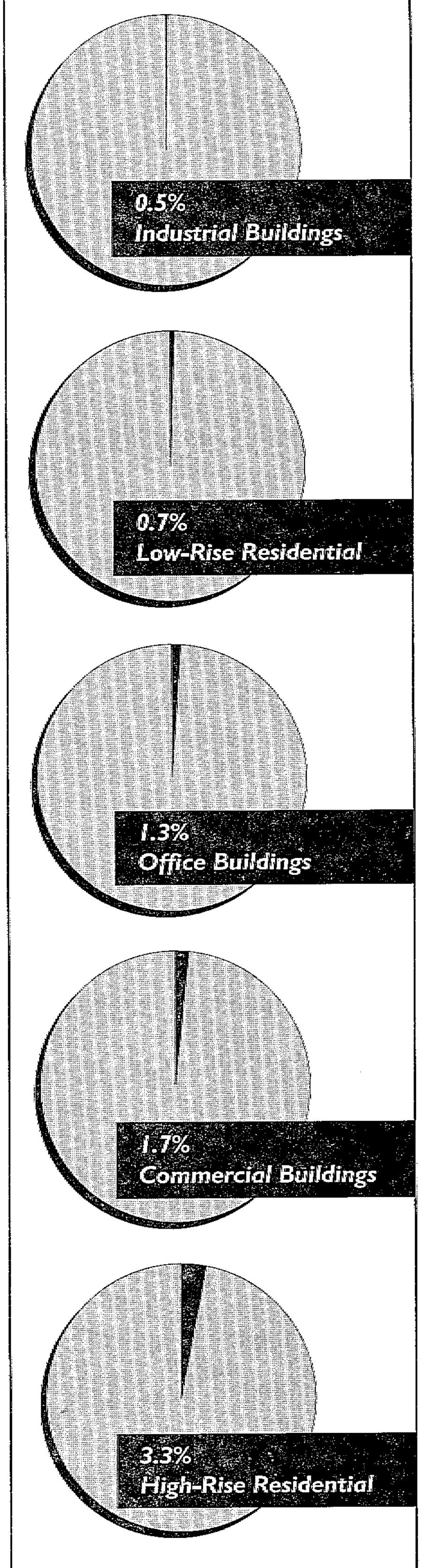
Costs of seismic design can vary. It is easier to provide seismic design for simple-shaped structures, with basic geometric shapes such as a square, and cheaper to do it if seismic considerations are integrated into the earliest stages of building design. In certain situations, the costs for the structure are relatively small in proportion to the total project costs. This occurs if the project has expensive contents or high land values. If this is the case, the cost of seismic-resistant design

Studies Indicate That the Benefits Outweigh the Costs

A few studies have attempted to look at the costs and benefits of seismic design provisions. The studies generally indicate that the costs of seismic-resistant construction are justified.

A 1992 study, *Physical Damage and Human Loss: The Economic Impact of Earthquake Mitigation Measures*, funded by the National Committee on Property Insurance (now IBHS), analyzed the estimated costs and benefits of seismic building codes for Memphis, Tennessee, assuming damage from magnitude 6 and 8 earthquakes in the southern New Madrid fault zone. It found that benefits exceed costs by a factor of 1.8 for the magnitude 6 event and 10.3 for the magnitude 8 event. Moreover, the benefit-cost ratio averaged over a forty-year time horizon, accounting for the expected probability of earthquakes in that time period, was estimated at 3.3. Thus, the expected damage over forty years is more than three times greater than the costs of building to code. Furthermore, the benefits are underestimated because they do not account for the benefits of reducing fatalities, injuries, fire potential, or economic losses. This recent study provides valuable analytic support to the claim that seismic building codes are cost-effective, even in the central United States.

Increase in Cost by Building Type Resulting from Seismic Design



Group Exercise #2: Responding to Arguments Against Seismic Codes

1. List the local arguments against seismic codes:

2. How might you respond?

3. Who is likely to oppose having seismic codes?

4. Who is likely to support having seismic codes?

Arguments in Favor of Seismic Codes

For elected officials: A damaging earthquake can occur during your term of office. The levels of ground-shaking represented on the code's seismic hazard map have a 0.8 percent chance of occurring in any four-year period at each point on the map (such as the community in question), and about a 2 percent chance of occurring in any eight-year period. But these are the *design events*. What about a lesser earthquake? An earthquake half as big as the design event could cause severe damage to many structures not meeting the code and little damage to structures built according to seismic code. Such an event has about a 4 percent chance of occurring in any four-year period and about an 8 percent chance in an eight-year period.

For elected officials: Citizens support seismic codes. Studies in California and the central United States have shown that most citizens support seismic building codes, and that elected officials underestimate this support. For example, in 1984 Arizona State University surveyed residents and officials in the high seismic risk area surrounding the New Madrid fault zone. The survey found that 62 percent of residents believed that seismic building codes for new structures are "very important," and most supported codes even if substantial costs would be involved. In contrast, support by community leaders was much lower at 37 percent. Furthermore, other studies have shown that community leaders greatly underestimate the public's concerns about earthquakes, mistakenly believing public concern to be less than their own.

In a 1994 telephone survey of residents in six hurricane-prone areas, 91 percent of respondents indicated that builders should be required to follow new, stricter building codes even though it might add 5 percent to the cost of a home.

Codes will not hurt business. Building codes have not hurt the economies of the forty-one states that have them, nor have they hurt the 95 percent of all U.S. cities and towns that have codes. Seismic design adds only approximately 1 to 1.5 percent to the cost of a building, according to a 1985 Building Seismic Safety Council (BSSC) study.

Is there a chance that local buildings will be shaken by an earthquake at some point? An earthquake can devastate the small businesses in a community. Following the 1994 Northridge, California earthquake, thousands of small businesses had to relocate or temporarily shut down. Such interruptions can be fatal to small businesses. Simply the loss of business activity can affect neighboring businesses that are fortunate to survive the earthquake ground-shaking.

A seismic code will improve successful survival of the next earthquake. People will live and work in these buildings. Codes work. Look at the evidence of relatively low loss of life in the earthquakes in California in 1989 and 1994. Either a community is designed to survive the next earthquake, or it is not.

Everyone else is doing it. The federal government has set an example with Executive Order 12699. Seismic codes are becoming more prevalent at all levels of government, which means two things: (a) a community will not be at an economic disadvantage for attracting new business and (b) if other communities adopt seismic provisions, those that do not have this safeguard in place invite liability.

It's easy. It doesn't take much to start. Call up a code organization, buy the code, develop a fee structure (to pay for administration), and contract with the county or another nearby agency for initial staffing.

It's good for the community. With a seismic code, residents will know that the community is on its way to seismic safety. The code will reduce long-term liability costs. A good code may ultimately improve the community's insurance rating. A seismic code is not an admission of community weakness, but rather a sign of community strength. It says that the community values safety, takes itself seriously, and wants to survive natural disaster. All communities need a seismic code regardless of hazard. Seismic codes supplied by the building code organizations account for the unique level of hazard in each community. If a community's hazard is low, the code will reflect that. The seismic hazard zone map is based on the latest national scientific evaluation of earthquake risk, representing the consensus of a number of scientific and professional organizations. The code requirements for each community reflect that estimate of hazard.

Enforcing the Seismic Code: A Critical Link

Poor Code Enforcement Results in Deficient Buildings

Recent studies following Hurricanes Hugo and Andrew have shown weaknesses in code enforcement. In 1991 State Farm Insurance Company contracted with SBCCI to evaluate code compliance in twelve randomly selected coastal communities. They found that inspectors and reviewers had little or no training in wind-resistant construction and that there was a general lack of enforcement of adequate connections of windows, doors, and mechanical equipment to the building frame. About half of the communities were not enforcing their own code standards for wind resistance.

Following Hurricane Andrew, reports by a Dade County grand jury and by the Federal Insurance Administration concluded that a substantial portion of the storm's damage was attributable to lack of enforcement of the South Florida Building Code. According to the Insurance Services Office, Inc., at least one-fourth of the record $15.5 billion in insured losses caused by Andrew were because of construction that failed to meet Dade County's code. Thus, even in communities with adequate codes, significant damage can be attributed to poor compliance and enforcement.

In a 1993 study, G.G. Schierle of the University of Southern California found significant problems in quality control of seismic-resistant construction in California. By means of a survey of design professionals and site inspection of 143 projects, the researchers found that key items to resist seismic load are frequently (13 to 72 percent of surveyed units) missing or flawed. Reasons include "inadequate communication, little or no construction observation by design professionals, ignorance, greed, shortsighted false economy, and lack of scrutiny by building inspectors."

Clearly, much effort needs to be spent on improving code enforcement. The weaknesses become apparent only at the moment when resistance is most needed—when the disaster strikes.

Benefits to Communities That Enforce Building Codes

Insurers and lenders have begun to realize that adoption and enforcement of building codes in general, and seismic codes in particular, are in their long-term interest. Accordingly, in 1995 the Insurance Services Office, Commercial Risk Services (ISO/CRS) began to phase in a new Building Code-Effectiveness Grading Schedule. By the end of the decade, this schedule will rate the code-enforcement capabilities of every municipality in the United States.

The insurance industry is developing this new grading schedule to reward communities for promoting property and life safety protection through the use and enforcement of modern codes. The system will be used by property insurers to set differential rates among communities based on code-enforcement practices. Property owners in communities with good code enforcement will pay lower insurance premiums—and owners in communities with poor enforcement will pay more.

The grading schedule measures resources and support available to building code enforcement efforts. It assesses each municipality's support for code enforcement, plan review, and field inspection. The grading process includes interviews with municipal officials, examination of documents, review of training requirements and work schedules, staffing levels, and certification of staff members.

The new system is comparable to the fire protection grading system and the community rating system for flood insurance already used by ISO/CRS. These two systems use a rating scale of one to ten, with one representing the best protection and ten indicating no protection.

For more information, contact the coordinating body, the Insurance Institute for Property Loss Reduction.

Five Elements of Effective Code Enforcement

Code enforcement and administration consist of five sequential elements.

Element 1: Keep the Code Provisions Up To Date

Simply adopting a code is not enough. A code is an active document, evolving to reflect new knowledge and new standards of practice. Once a jurisdiction makes a commitment to use a building code, it must be prepared to update its local code on a regular basis.

Element 2: Ensure That Builders Apply for Permits

Obviously, if builders try to avoid the code-application process, then the code cannot do its job. A jurisdiction must have inspectors out in the field who know the community. The inspector needs to be alert to new construction in his or her jurisdiction and must be aware of current active permits.

In addition, the building department must cultivate and maintain cordial relations with the building and design community. This can be done by arranging informal meetings, sending written materials to local organizations, speaking to community groups, and maintaining memberships in appropriate trade and professional organizations.

Element 3: Have a Qualified Reviewer Review Plans

Plan review is one of the two points at which the local government can affect the details of building construction. At a minimum, plan review verifies that the design complies with the building code. This is the most cost-effective moment to catch mistakes, before any money is spent on construction. Some jurisdictions may also review structural calculations.

Plan reviewers must be fully knowledgeable about code requirements. Some jurisdictions use licensed architects and engineers who can go beyond code compliance review and verify calculations and overall building safety. The building department can approve, require revisions, or reject the plans. Construction cannot begin until the building department confirms that the plans conform to the building code.

Construction of buildings larger than one- or two-family dwellings usually requires architectural and engineering designs. State statutes require that the licensed professional engineer and/or architect place his or her seal and signature on the designs. The seal and signature signify that the design is at the accepted professional standard, which is typically the most recent version of a model building code or technical document.

Element 4: Ensure That Construction Proceeds According to Approved Plans

An owner receives a building permit to construct according to the approved plans, and it is the legal responsibility of the owner to do so. The owner may hire inspectors or the engineers and architects to oversee key aspects of the construction in order to help verify compliance with the plans. To some extent, all government inspection systems depend on this obligation by the owner, which is inherent in the issuance of a permit.

Element 5: Have a Qualified Inspector Inspect the Construction

Inspection is the second point at which the local government can affect the details of building construction. Inspection verifies whether construction is proceeding according to the approved plans and the conditions of the permit. Inspection is typically required at several key stages in the construction process. The inspector has a powerful enforcement tool called a stop work order. A stop work order is issued to the construction firm if the inspector finds a code violation that must be corrected before any further construction is performed. At final inspection, the building can be approved for occupancy.

Depending on the jurisdiction, inspectors may be municipal employees or contracted tradespeople. In either case, building inspectors must be well qualified. They must know how to read building plans and must be familiar with the code. More importantly, they must be familiar with building practices so they can recognize potential problems. Model code organizations offer certification programs to recognize the capabilities of inspectors.

Group Exercise #3a: Action Plan to Adopt a Building Code

Develop a ten-point action plan that will result in a building code (with current seismic provisions!) for this community:

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

Group Exercise #3b: Action Plan to Improve Code Enforcement

Develop a ten-point action plan that will result in improved code enforcement for this community:

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

Steps Toward Adopting Seismic Code Provisions

Step 1: Determine Code Practices and Options

- To whatever extent the state regulates construction, satisfy yourself that enforcement is adequate.
- If the state mandates local adoption of a specified code, ensure that the community has complied.
- If the state does not currently regulate, or if it allows for stricter local regulations, gather information on local code practices and explore options at the local level.
- Options may include developing an original code, modifying an existing code, or adopting a model building code.
- If a jurisdiction lacks an adequate code, work to initiate a building code.
- Model codes are usually the best option, because of the technical support provided by the code organization.

Step 2: Gather Support

- Work with state officials
- Work with the professional associations of engineers and architects
- Contact civic groups and service clubs, relevant businesses and construction organizations, chambers of commerce, economic development associations, and so forth
- Cultivate the media to help educate the general public

Step 3: Lobby the Decision-Making Body

- Explain why the changes are needed and describe the kind of support you have gathered.
- Gain the support of the governor's office.
- Consider educational programs or incentive programs that will appeal to governmental officials
- Consider ways of subsidizing the cost of joining a model building code organization
- Monitor the process from beginning to end

Step 4: Assist Throughout the Adoption, Implementation, and Enforcement Stages

- Provide information about seismic hazards in the area, the function and effectiveness of seismic codes, elements of code enforcement, and services provided by the model code organizations
- Keep informed of implementation milestones
- Meet periodically with the building official(s)
- Verify that adequate procedures have been introduced for plan review, inspection, and staff training
- Inform the building officials of any problems

Steps for Enforcement of Seismic Codes

This section outlines the six steps toward establishing an effective building code program.

Step 1: Adopt a Model Code

The first step in establishing a program is to review and adopt a model building code and join the appropriate code organization. Numerous publications and telephone-assistance services will then be available to help the new program get started. The information provided includes organization charts, descriptions of staff duties, fee structures, suggested procedures, and so on. New members may want to take seminars in plan review and inspection before officially initiating the code.

New members can request the model code staff to visit and assist in establishing their program. If extensive help is required, the code organization may be hired to provide the needed assistance. It is easy to get started, because the code organizations are set up to effectively and efficiently provide all the support you need.

Step 2: Establish Fee Structures for Permits and Plan Review

Building departments collect fees to pay for the costs of review, inspection, and associated administrative services. The community sets the fee structure based on its needs. Some communities require the building department to be completely self-supporting; others use the fees to offset only a portion of their true costs. Communities with significant experience in code administration can set fees based on previous budgets. Communities just starting out may prefer to use the fee structures suggested by the code organizations.

Plan review fees typically are based on estimated construction value, which depends on building floor area, type of construction, and proposed use. For example, under the BOCA NBC, the suggested building plan review fee for $1 million construction value is $1,250. Review for mechanical work, plumbing, energy conservation, or electrical work is an additional 25 percent each (i.e., each of these additional reviews, if required, costs $312).

Step 3: Institute a Systematic Plan Review System

Plans usually must be circulated to several additional departments for review, such as the planning, public works, and fire departments. It is best to have one department designated as the lead and to require multiple plan copies from the applicant so as to facilitate multi-department reviews.

Applicants should be kept well informed right from the start. Handouts and checklists are very important so that they know what materials to submit and how the plan will be judged.

Step 4: Adopt an Inspection Schedule

Each code has a recommended inspection schedule based on construction milestones. For example, the BOCA NBC suggests the following inspections for residential buildings: footing forms and trenches, basement and foundation wall forms, footing drains and damp proofing, framing, wallboard, and final. Similar schedules exist for electrical and mechanical work and plumbing.

Typically, the builder or owner will call for inspection when each specified milestone is reached. In addition, inspectors occasionally make unannounced inspections based on their judgment of the work progress and the quality of the contractor.

Step 5: Maintain a Trained, Qualified Staff

Ideally some staff members would be licensed engineers and architects, but most departments are too small to justify this cost. At a minimum, reviewers and inspectors must have experience in construction, be able to read plans, and be familiar with the code. Each of the model building code organizations offers certification in a number of categories for inspectors and plan reviewers. More and more building departments are requiring or rewarding certification in order to recognize staff quality levels.

Step 6: Be Persistent But Patient

You need to realize that a new code will not be implemented in one day. Adequate enforcement takes many years of experience and learning from mistakes. Procedures evolve over time. Building officials, plan reviewers, and inspectors must receive technical training and continuing education, which cannot be done overnight. Yet the effort is worth it, as seismic codes afford communities a high degree of improved building safety.