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16. Abstract (Limit: 200 words)
The 25 papers and presentations of this volume present a variety of approaches for improving the earthquake safety and preparedness of schools and school children, especially in the Northeastern United States. This regional emphasis is established by historical surveys of Northeastern seismicity, a presentation on earthquake loss analysis in Boston and its environs, and an account of the Massena, New York earthquake of 1944. Other presentations discuss earthquake preparedness activities within the school system of New York State. The remainder of the presentations and papers treat the integration of earthquake education materials into the curriculum, nonstructural hazards in the school building, earthquake emergency drills, and the psychological effects which young children and adolescents experience during and after earthquakes.

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Elementary education. Nonstructural hazards. School buildings. Children.
Boston, Massachusetts. Massena Center, New York earthquake, 1944.
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NATIONAL CENTER FOR EARTHQUAKE ENGINEERING RESEARCH
State University of New York at Buffalo

Proceedings from Earthquakes in the Northeast— Are We Ignoring the Hazard? A Workshop on Earthquake Science and Safety for Educators

Edited by

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Technical Report NCEER-93-0005

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NOTICE

Proceedings from
Earthquakes in the Northeast - Are We Ignoring the Hazard?
A Workshop on Earthquake Science and Safety for Educators

held at the
New England Center
University of New Hampshire
Durham, New Hampshire
on
September 25-26, 1992

Edited by Katharyn E.K. Ross[1]
April 2, 1993

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1 Education Specialist, National Center for Earthquake Engineering Research

NATIONAL CENTER FOR EARTHQUAKE ENGINEERING RESEARCH
State University of New York at Buffalo
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Part I

Overview

Section 1
Introduction

by Katharyn E.K. Ross
Education Specialist
National Center for Earthquake Engineering Research

Earthquakes have damaged schools. August 31, 1886, damage occurred at Charleston College in an earthquake that killed 60 residents of Charleston, South Carolina. March 10, 1933, in Long Beach, California, the John Muir School on Pacific Avenue and the wall of the dance hall building in Compton High School collapsed. October 31, 1935, the west wing of the new Helena High School collapsed in an earthquake in Helena, Montana; the collapsed part of the school had reinforced concrete frame, floors, and roof, and tile floors faced with brick. August 18, 1959, in Hebgen Lake, Montana, the decorative stone entryway was shaken down at the West Yellowstone Elementary School. Government Hill Elementary School was split in two during the Good Friday earthquake (March 27, 1964) in Anchorage, Alaska.

At 4:42 P.M. on Monday, May 2, 1983, a 6.5 magnitude earthquake struck Coalinga, California. Seconds later, there was an after shock of 5.0 on the Richter Scale. A report prepared after this earthquake by E. Robert Bulman for Charles S. Terrell, Jr., Superintendent of Schools for San Bernardino County, California, noted nonstructural damage to the schools. For example, about 1,000 fluorescent light bulbs fell from the fixtures and broke. Improperly installed T-bar ceilings fell as well as glued ceiling tiles. Water pipes located in the basement were broken, flooding the basement and stopping the electrical supply because all the switching mechanisms were damaged by water. In a second floor chemistry lab in the high school, bottles of sulfuric acid and other stored chemicals fell and broke. Acid burned through to the first floor. Because there was no electrical power to drive the ventilating system, poisonous fumes filled the building. Superintendent Terrell feels that death and serious injury would have resulted had school been in session. This damage could have been minimized had school personnel reviewed and remedied some of the potential hazards prior to this earthquake.

Structural and nonstructural damage should not be our only concern. Children and their teachers do not automatically know what to do in an earthquake. In a preliminary study in which 35 elementary students in New York State were interviewed, Ross and Shuell (1989) found that only 9% gave clearly correct answers to questions about what to do in an earthquake. The interviews also revealed that elementary school children had misconceptions about earthquakes, what occurs during an earthquake, and what causes an earthquake. Subsequent interviews of students in fourth through sixth grades have continued to support these observations (Ross & Shuell, 1990a,b).

Earthquakes remain a potential hazard that is not restricted to the western part of the United States. As Table 1 illustrates, earthquakes have occurred in the northeastern part of the United States and adjacent Canada. Although there are longer intervals between earthquakes in the Northeast, the potential for damage exists.

Children spend a significant portion of their day in schools. The school community needs to be well-prepared to meet school earthquake emergencies in order to protect the welfare of students and staff both during and after the ground shaking. In addition, tomorrow's adults need to be aware of the dangers that earthquakes present and how to achieve a greater level of safety through building codes to ensure more earthquake resistant structures, training in earthquake safety actions to take during and after an earthquake, and improved levels of preparedness in schools, homes, and businesses. Earthquake education can provide insight into solving problems in science as well as making our environment a safer place to be.

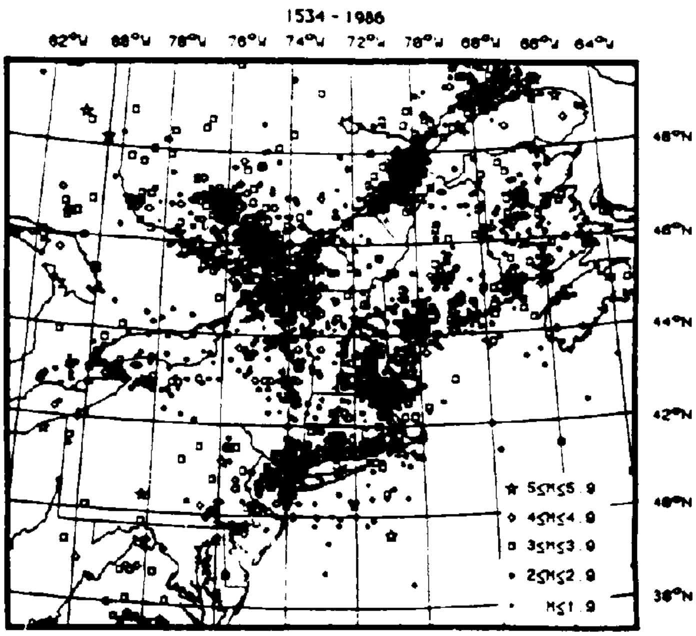
References

Ross, K. E. K., & Shuell, T. J. (1989, October). Children's beliefs about earthquakes. Paper presented at meeting of the Northeastern Educational Research Association, Ellenville, NY.

Ross, K. E. K., & Shuell, T. J. (1990a, November). The earthquake information test: Validating an instrument for determining student misconceptions. Paper presented at meeting of the Northeastern Educational Research Association, Ellenville, NY.

Ross, K. E. K., & Shuell, T. J. (1990b). After Loma Prieta - what do children outside of California believe about earthquakes? Unpublished manuscript.

Table 1 - Earthquake Activity in the Northeastern United States



Map at left shows all known earthquake activity for the Northeastern U.S. and adjacent Canada. From "Seismicity of the Northeastern United States", John E. Ebel, NCEER Technical Report NCEER-87-0025, December, 1987, p. 178-188.

Significant Earthquakes: New York State and Surrounding Areas
1534 - Present

Date	Location	MMI	Mag.	Date	Location	MMI	Mag.
1534-1535	St. Lawrence Valley,	IX-X		1897	Plattsburgh, NY	VI	
1638	St. Lawrence Valley,	IX		1916	Mohawk Valley, NY	VI	
1663	Charlevoix, Que.	X	7.0*	1925	Charlevoix, Que.	IX	7.0*
1727	Near Newbury, MA	VIII	7.0*	1928	Saranac Lake, NY	VI	4.1
1732	Near Montreal, Que.	VIII		1929	Attica, NY	VIII	5.5*
1737	New York, NY	VI	4.8	1929	Grand Banks, Nfld.	X	7.2
1755	Near Cape Ann, MA	VIII		1931	Warrensburg, NY	VII	4.5
1791	E. Haddam, CT	VIII		1934	Dannemora, NY	VI	4.5
1817	Woburn, MA	VI-VIII		1935	Timiskaming, Que.	VIII	6.0*
1840	Herkimer, NY	VI		1944	Massena, NY	VIII	5.6
1853	Lowville, NY	VI		1944	Massena, NY	(aftershock)	4.5
1857	Buffalo, NY	VI		1966	Attica, NY	VI	4.6
1860	Charlevoix area, Que.	VIII-IX	6.0*	1967	Attica, NY	VI	4.4
1867	Canton, NY	VI	4.8	1982	Miramichi, NB	V	5.7
1870	Charlevoix area, Que.	IX	6.5*	1982	Franklin, NH	VI	4.8
1874	Tarrytown, NY	VI		1983	Goodnow, NY	VI	5.2
1884	Rockaway Beach, NY	5.0		1986	N.E. Ohio	VI-VII	5.0
				1988	Chicoutimi, Que.		6.0

** indicates approximate surface-wave magnitudes*

New England States Earthquake Consortium (NESEC)

by Louis Klotz
Executive Director
New England States Earthquake Consortium

On behalf of the Board of Directors of the New England States Earthquake Consortium (NESEC), as well as myself, welcome to the Northeastern Earthquake Education Workshop on *Earthquakes in the Northeast - Are We Ignoring the Hazard?*

NESEC's Basis

In October 1977, Congress passed Public Law 95-124, the *Earthquake Hazards Reduction Act of 1977*, which legislatively addressed earthquake hazards in this country. The *Act* specifically states, based on USGS studies, that 39 of the 50 states are subject to major or moderate seismic risk and are therefore vulnerable to the hazards of earthquakes. Massachusetts is one of the 13 states specifically lasted in the *Act* as examples of states at risk, but all 6 New England States are classified as at moderate risk[1].

Under this *Act*, the Director of the Federal Emergency Management Agency (FEMA) was required to prepare a written Program plan, the *National Earthquake Hazard Reduction Program (NEHRP)*. The most recent amendment to the *Act* is the *NEHRP Reauthoriza.ion Act of 1990* (P.L. 101-614) and the most recent Program plan is the *National Earthquake Hazards Reduction Program Five-Year Plan: 1989-1993.*

NEHRP endorses the creation of regional groups of states for earthquake risk management to reduce future losses of life and property from earthquakes and is the basis of NESEC's creation.

NESEC's Structure

The New England States Earthquake Consortium (NESEC) was incorporated in October 1991 in Massachusetts as a non-profit, educational corporation. Its structure is a somewhat unusual, although not unique, collaboration of similar agencies from the individual New England States. NESEC's Board of Directors, by its Articles of Incorporation, is composed of the six Directors of the New England States' Emergency Management Agencies. That is, the designation of being a member of NESEC's Board of Directors is based on a specific New England State government position. With these designations, the Board currently consists of:

Chairman: George L. Lowe, Director
Division of Emergency Management, Vermont

Treasurer: George L. Iverson, Director
Office of Emergency Management, New Hampshire

Clerk: A. David Rodham, Director
Emergency Management Agency, Massachusetts

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[1] Moderate risk relates to the fact that New England's earthquakes have a long earthquake reoccurrence interval; not that the earthquake magnitudes or their impact on the population or built environment will be necessarily "moderate."

problems, requirements and opportunities. Another way of looking at it, is that it can be truly stated that when one New England state shakes, the other five rattle.

The Earthquake Program Managers at the State emergency management offices are:

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Part II

Setting the Stage

A Historical Look at Earthquakes in the Northeast

by Walter Mitronovas
Associate Scientist, Seismology
Geological Survey, New York State Museum

Gary N. Nottis
Research Scientist, Seismology
Geological Survey, New York State Museum

Abstract

Earthquake activity has been recorded for more than 400 years for parts of the northeastern United States. Present day earthquakes, with some exceptions, occur in the same geographical areas where historical earthquakes have taken place. Once recent exception was a magnitude 4.0 earthquake that occurred on June 17, 1991, in Schoharie County, New York. Some areas show fluctuations in earthquake activity with time. For example, eastern Massachusetts had more felt earthquakes in the 1600s and 1700s than it does today. Over 40 damaging earthquakes are known to have occurred in the northeast since the mid 1500s. About 30 of those events caused slight damage (I_o = VI(MM)). Another 11 events caused moderate damage (I_o = VII(MM)). Two events caused considerable damage (I_o = VIII(MM)). The first of these occurred on November 18, 1755, near Cape Ann, Massachusetts, with an estimated magnitude of 6.0. It damaged many chimneys in Boston; bricks, tiles and slates fell into the streets, roofs collapsed, and building foundations were damaged. The second event occurred near Massena Center, New York, on September 5, 1944, and had a magnitude of 6.0. It caused over 16 million dollars of damage (1989 dollars) in Massena, New York, and Cornwall, Ontario. Electrical service was disrupted and water pipes were broken. More than 5,100 chimneys were damaged or destroyed. There were also numerous reports of broken windows, cracked cement and masonry walls, and fallen ceiling and wall plaster. A few older brick buildings in the Massena area were declared unsafe and demolished. Significant damage occurred in schools in Massena and Cornwall. Larger destructive earthquakes are known from adjacent Canada. We feel that the known earthquake history of the Northeast is too short to indicate whether the geographical pattern of earthquake activity will change significantly or not. A low rate of earthquake activity in the Northeast, combined with a short earthquake history, also prevents us from knowing how often a damaging event will occur. A damaging event may next take place tomorrow or hundreds of years from now. Expert opinions agree that earthquakes of magnitude 6.0 or greater could occur anywhere in the northeastern United States. In some parts of the region, even larger events could occur. The history of earthquakes in the northeastern United States serves to warn us that steps need to be taken to prepare for damaging events. The question of how much preparation is needed has not been decided.

Introduction[2]

- It is hard to imagine calling the northeastern United States, "Earthquake Country." That title is usually bestowed upon California, in the minds of most people living in the United States.

[2] Presentation notes.

- Present day earthquakes, with some exceptions, occur in the same geographical areas where historical earthquakes have taken place.

Slide Three (see figure 3)

- The same broad zones of seismicity are still apparent if we examine only earthquakes of magnitudes (M_N) $\geq$ 3.0, during the period of October 1975 to March 1989.

- Whether we talk about the historical record of seismicity or the recent record, earthquakes that have produced strong shaking or damage ($I_o \geq$ V[MM]), have been concentrated primarily in the broad zones of activity.

- There are some differences between the historical and recent records in the spatial distribution of activity.

- One recent example was a magnitude (M_N) = 4.0 earthquake that occurred on June 17, 1991, in Scholharie County, New York. Another was the magnitude (M_N) = 6.5, damaging earthquake that took place November 25, 1988, in the Saguenay region of Quebec.

Slides One and Three

- Both events occurred in areas with little or no known previous seismicity. This can be seen when comparing Slides One and Three. The epicenter of each earthquake is noted on each slide by an arrow and the date of occurrence.

- Do the June 1991 Schoharie County and November 1988 Saguenay earthquakes signal the birth of new areas of persistent seismicity in the northeastern United States and southeastern Canada? It is possible. A second possibility is that the occurrence of those events might indicate only <u>rebirth</u> of activity in areas that were active earlier.

Slide One

- Some portions of the Northeast have experienced fluctuations in the rate of seismicity over time. For example, eastern Massachusetts had more felt earthquakes of $I_o \geq$ V(MM) in the 1700s, than today. Most of the activity shown in eastern Massachusetts took place during the 1700s.

- Earthquakes of $I_o \geq$ V(MM) took place at a rate of about one event every six years during the 1700s.

Slide Three

- Earthquakes capable of producing epicentral intensities (I_o) $\geq$ V(MM), generally have magnitudes (M_N) $\geq$ 3.0. Slide Three shows a lack of recent magnitude (M_N) $\geq$ 3.0 events in eastern Massachusetts.

- At least two magnitude (M_N) $\geq$ 3.0 earthquakes, each producing an epicentral intensity (I_o) $\geq$ V(MM), should have occurred during October 1975 to March 1989, if the rate of activity was the same as in the 1700s.

- Other portions of the Northeast that show similar behavior are western New York and the Lake Champlain Valley.

- Central New Brunswick may be acting the opposite. Seismicity has increased in that area since the January 18, 1982, magnitude (M_N) = 5.8 earthquake in that region.

- If we consider the historical record for the Northeast, we find that earthquakes that produce strong shaking or damage, cluster in time.

- Periods of greater activity, for such events, took place from:

  1. 1700-1750
  2. 1840-1890
  3. 1910-1950

- Temporal clustering of magnitude (M_N) $\geq$ 3.0 earthquakes in New England has also been observed in the more recent activity.

Damaging Earthquakes

Slide Four (see figure 4)

- More than 40 damaging earthquakes are known to have occurred in the Northeast since 1727 (see table 1).

- About 35 of these events caused slight damage ($I_o \geq$ VI(MM). Another 7 events caused moderate damage ($I_o \geq$ VII(MM). Two events caused considerable damage ($I_o \geq$ VIII(MM).

Slide Five (see figure 5)

- The first of those two events occurred on November 18, 1755, near Cape Ann, Massachusetts (estimated magnitude [M_N] = 6.0). It damaged many chimneys in Boston; bricks, tiles and slates fell into the streets; roofs collapsed; and building foundations were damaged. The same kinds of damage occurred in communities along the Massachusetts coast, from Braintree to Ipswich.

- Slide Five shows an *isoseismal* map for the 1755 earthquake. The solid and dashed isoseismal lines enclose areas of equal ground shaking. The roman numerals denote the severity of ground shaking on the *Modified Mercalli Scale of 1931* (see table 3).

- *Aftershocks* of the November 18, 1755 *main shock* were felt in eastern Massachusetts for at least a year. The largest aftershock occurred on November 22, 1755, near Cape Ann, Massachusetts. That event had an epicentral intensity (I_o) $\geq$ V(MM) and caused no damage.

Slide Six (see figure 6)

- The second event occurred near Massena Center, New York, on September 5, 1944, and had a magnitude (M_N) = 6.0. It caused more than 16 million dollars in damage (1989 dollars) in Massena, New York, and Cornwall, Ontario. Electrical service was disrupted and water pipes were broken. More than 5,100 chimneys were damaged or destroyed. There were also numerous reports of broken windows, cracked cement and masonry walls, and fallen ceiling and wall plaster. A few older brick buildings in the Massena area were declared unsafe and demolished.

- Slide Six is an isoseismal map for the Massena Center, New York, earthquake.

- Felt aftershocks occurred in the Massena Center, New York, area for over four months following the main shock. The strongest aftershock, in terms of ground shaking, took place on September 9, 1944, and had an $I_o \geq$ V(MM). Further damage occurred to chimneys already weakened by the main shock.

Slide Seven[4]

- This slide shows cracks up to 2 inches wide, in the exterior brickwork of the old Baptist Church in downtown Massena, New York.

Slide Eight[4]

- This slide shows the front of the Massena Town Hall as it appears today. It looked much the same in 1944. The September 5, 1944 earthquake caused the large stone block facade of the Town Hall to bulge outward. The bottom third of the facade had to be removed and put back into place.

Slide Nine[4]

- This slide shows damage to the brick facade of a home in Cornwall, Ontario, Canada. Note the cracks in the mortar between bricks and the large section of missing bricks.

- Significant damage occurred in schools in Massena and Cornwall.

- In Massena, fallen plaster and broken windows were reported for nearly all the public schools. Some masonry damage was reported, and we suspect that there was damage to building contents.

- The same kinds of damage occurred to schools in Cornwall.

Slide Ten[4]

- The most spectacular damage resulted when brick coping on the new Cornwall High School broke away and fell through the timber roof of the gymnasium, three stories below.

- This slide shows the destroyed gymnasium roof of the Cornwall High School.

[4] Figure not available for inclusion with these notes.

- Even more destructive earthquakes are known from adjacent Canada, where over 30 damaging events have occurred since 1534 (see table 2).

- When considering the record of damaging earthquakes in terms of what could happen today, we must keep two important caveats in mind:

  1. a repeat of some of these events, especially near major metropolitan areas, could be far more damaging today, then they were in the past, and

  2. most of these damaging earthquakes took place before there was a high density of people and buildings in cities such as, New York and Boston.

- For example, an earthquake, with an estimated magnitude (M_N) = 5.0 took place off southwestern Long Island, New York, on August 10, 1884. That event caused only slight damage. However, much of Long Island was farm country then.

- Today, it is believed that an earthquake of magnitude (M_N) = 5.0 could cause an estimated 2.0 billion dollars in damage on Manhattan Island, New York, alone.

- A magnitude (M_N) = 6.0 earthquake might cause over 11 billion dollars in damage in New York City.

- In contrast, the 1989 Loma Prieta, California, earthquake (magnitude 7.1) caused 6-7 billion dollars in damage.

- Few people have been injured as a direct result of earthquakes in our region. No one has been killed as a direct result of such events.

- There have been reported cases where people suffered psychologically from the effects of damaging earthquakes in our region.

When and Where Will the Next Damaging Event Be?

- We do not know.

- Statistically, we can calculate rates of seismicity for different portions of the Northeast and for the entire region.

- If we look at the earthquake record for the Northeast from 1727 to 1992, we find that damaging earthquakes occur at the following rates:

  1. earthquakes of $I_o \geq$ VI(MM) occur about every 6 years,
  2. earthquakes of $I_o \geq$ VII(MM) occur about every 30 years, and
  3. earthquakes of $I_o \geq$ VIII(MM) occur about every 130 years.

- But, considering:

  1. that we have an overall low rate of seismicity,
  2. the short length of the earthquake record,
  3. the fluctuations in activity, and
  4. the apparent clustering of larger earthquakes, in time,

  we wonder just how useful are these numbers?

- A damaging earthquake may next take place tomorrow or decades from now.
- The only certainty we have is that another will take place.
- We know that nearly all past damaging earthquakes in the Northeast occurred in the broad zones of seismicity. Will that continue to be the trend?
- We feel that the known earthquake history of the Northeast is too short to indicate whether the geographical pattern of earthquake activity will change significantly or not.
- An important question we also need to answer is whether or not we have seen the largest earthquakes that will occur in the region?
- To get a hint, seismologists have looked at the earthquake histories of other continental regions around the world that are similar to the Northeast in terms of geology and seismology.
- Based on those studies, we conclude that we have yet to see the largest possible events.
- Most expert opinions agree that earthquakes of magnitude (M_N) = 6.0 could occur anywhere in the northeastern United States.
- In some parts of the region, even larger events could occur.
- To get a true understanding of temporal and spatial variations of the regional seismicity, we would probably need a record of activity thousands or even tens-of-thousands of years long.
- Trying to understand the pattern of earthquakes in the region is like trying to describe an entire movie based on just a few frames from the film. If you have just the right few frames, you can do it. Do we have just the right few frames?
- In spite of these difficulties, the history of earthquakes in the northeastern United States and southeastern Canada serves to warn that steps need to be taken to prepare for damaging events.
- The question of how much preparation is needed has not been decided.

Glossary

Aftershock. An earthquake that follows the *main shock.*

Aseismic. Lacking earthquake activity.

Earthquake intensity. A subjective description of an earthquake's effects on people, objects, and man-made structures, observed at a particular place on the Earth's surface.

Epicenter. Point on the Earth's surface directly above where an earthquake originates.

Epicentral intensity (I_o). ***Earthquake intensity*** at an epicenter.

Intensity scale. A standard of relative measurement of *earthquake intensity.*

Isoseismal. A line, drawn on a map, that encloses points of equal *earthquake intensity.* The earthquake intensity at a point is determined with an *intensity scale.*

Magnitude (M_N). A measure of the size of an earthquake based upon the amplitude of seismic waves or the duration of the earthquake, as recorded at a *seismograph.* M_N denotes a particular magnitude measure used in the northeastern United States and southeastern Canada. It is related to a Richter magnitude (M_L) by the relation: $M_L = M_N - 0.4$.

Main shock. The largest in a series of earthquakes occurring closely in time and at approximately the same place.

Modified Mercalli Scale of 1931. A twelve level *intensity scale*, ranging from I (not felt) to XII (total destruction), used in the United States to describe the felt effects of earthquakes (see table 3). A value on this scale is often denoted by a roman numeral followed by (MM).

Seismicity. Earthquake activity.

Seismic Waves. Vibrations that travel through the earth as a result of the release of energy, whether generated by natural or artificial means.

Seismograph. A sensitive device that can detect, amplify, and record *seismic waves* that are often too small to be noticed by people.

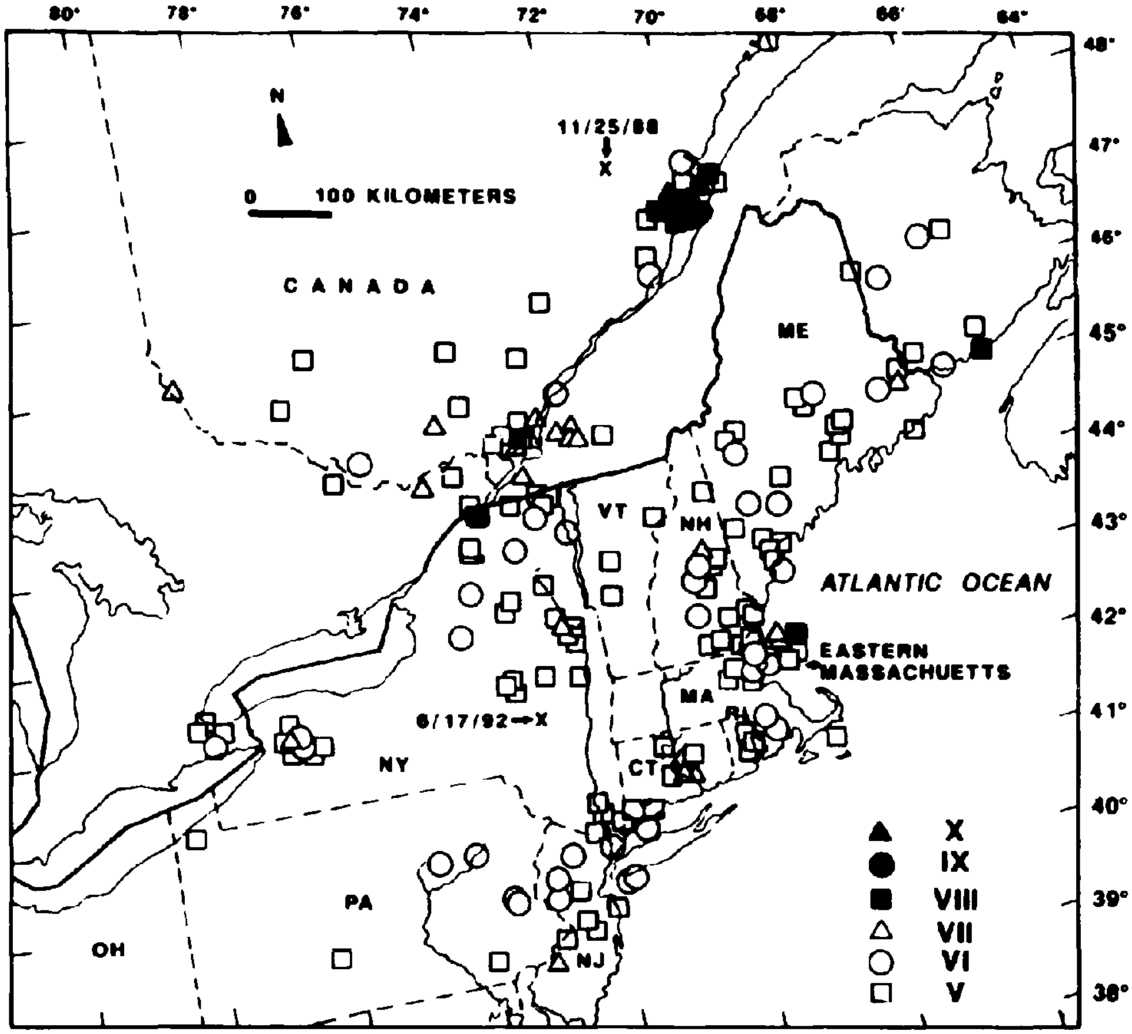

Figure 1: Felt historical earthquakes of the northeastern United States and southeastern Canada. The period covered is 1534 to September, 1975. Symbols show the epicenter and epicentral intensity (I_o) of each event. Epicentral intensities are given in terms of the Modified Mercalli Scale of 1931. The locations of the June 17, 1991, Schoharie County, New York, and November 25, 1988, Saguenay, Quebec, earthquakes are shown by X's and their dates of occurrence.

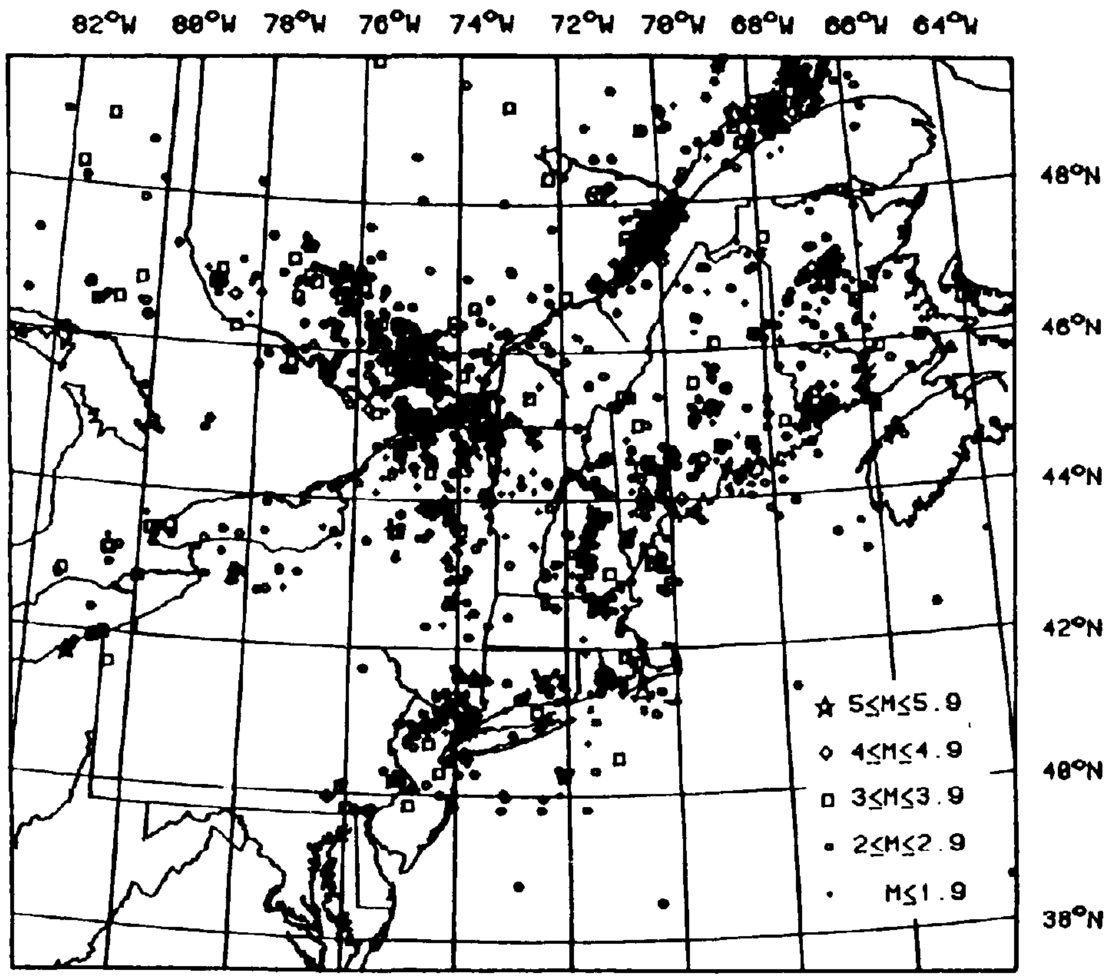

Figure 2: Earthquakes of the northeastern United States and southeastern Canada during the period of October 1975 to March 1989. Symbols show the epicenter and magnitude (M_N) of each event. The figure accurately depicts the epicenters of all earthquakes of magnitudes (M_N) ≥ 2.0 in the Northeast and of magnitudes (M_N) ≥ 3.0 in southeastern Canada. Figure courtesy of the Weston Observatory, Boston College.

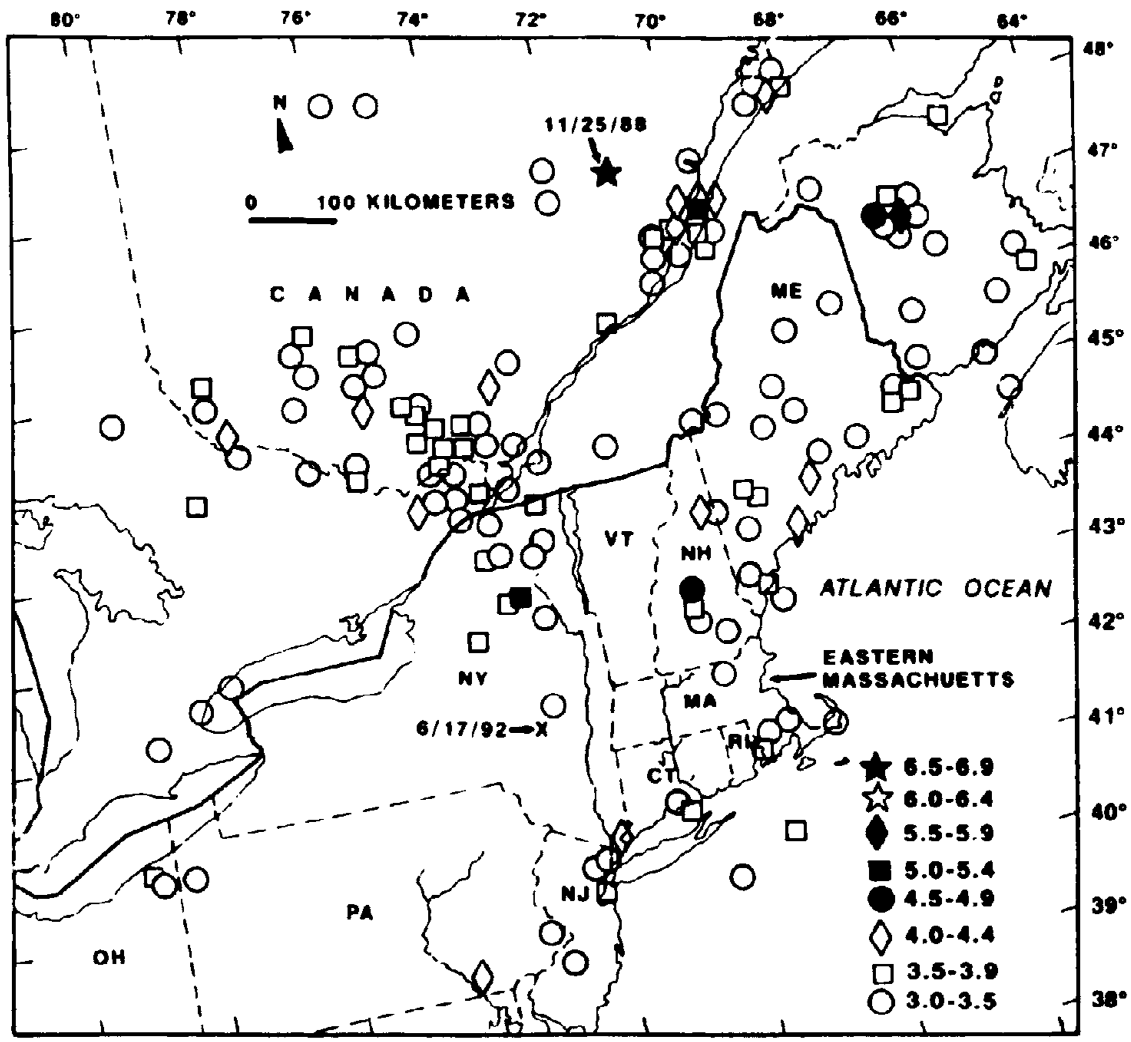

***Figure 3:** Magnitude (M_N) ≥ 3.0 earthquakes of the northeastern United States and southeastern Canada during the period of October 1975 to March 1989. Symbols show the epicenter and magnitude (M_N) of each event. Locations of the June 17, 1991, Schoharie County, New York, and November 25, 1988, Saguenay, Quebec earthquakes are shown by X's and their dates of occurrence.*

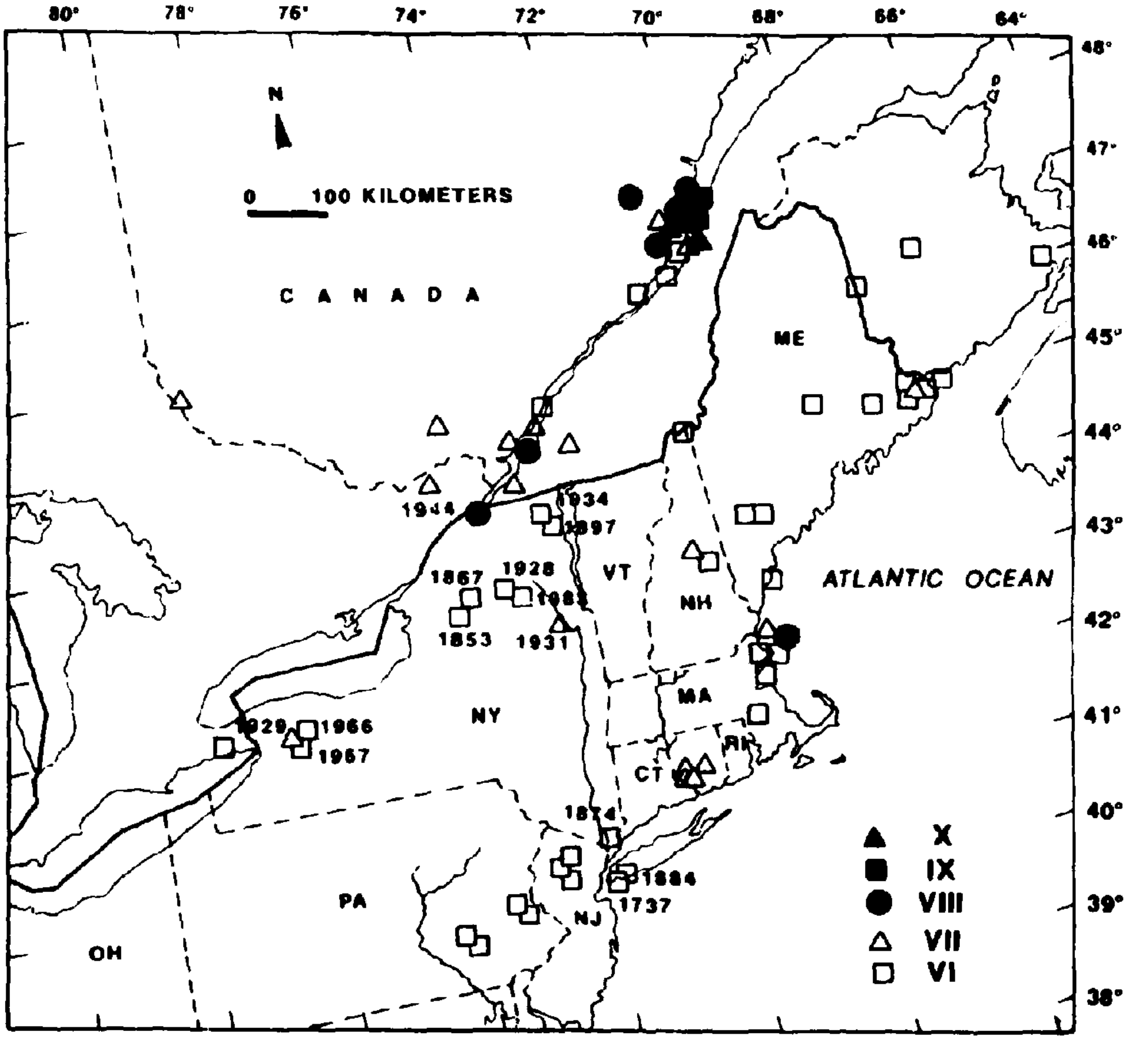

Figure 4: Damaging earthquakes of the northeastern United States and southeastern Canada during the period of 1534 to 1988. Symbols show the epicenter and epicentral intensity (I_o) of each event. Epicentral intensities are given in terms of the Modified Mercalli Scale of 1931. The year of occurrence appears next to New York State events.

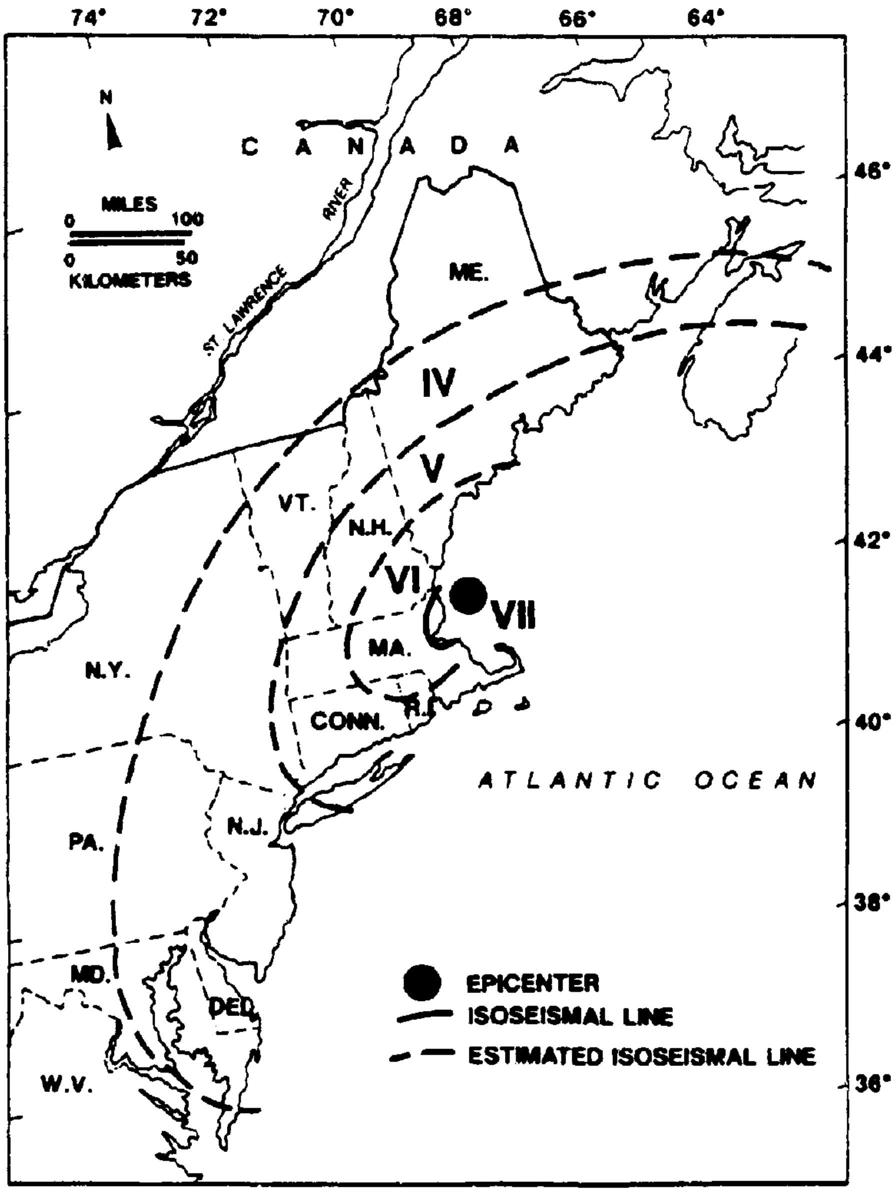

Figure 5: Isoseismal map for the November 18, 1755, Cape Ann, Massachusetts, earthquake. The solid and dashed lines enclose areas of equal ground shaking. The roman numerals denote the severity of ground shaking on the Modified Mercalli Scale of 1931.

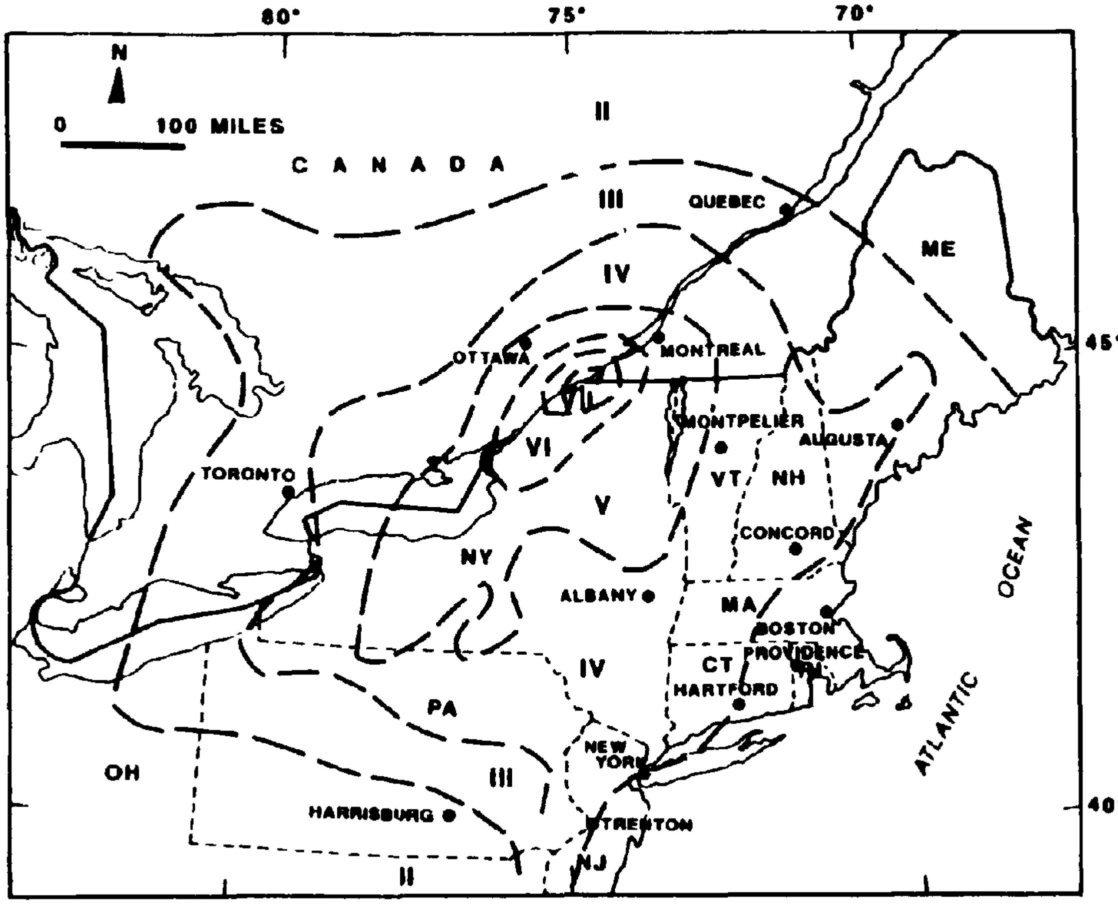

Figure 6: Isoseismal map for the September 5, 1944, Massena Center, New York, earthquake. The dashed lines enclose areas of equal ground shaking. The roman numerals denote the severity of ground shaking on the Modified Mercalli Scale of 1931.

Table 1: Damaging Earthquakes of the Northeastern United States, 1568-1988

Origin Time (GMT)						Epicenter			Epicentral	
Year	Month	Day	Hr	Mn	Sc	Latitude	Longitude	Magnitude (M_N)	Intensity (MM)	Locality
1568						41.50°N	72.50°W		VII(?)	CT Moodus - East Haddam
1574						41.50°N	72.50°W		VII(?)	CT Moodus - East Haddam
1584						41.50°N	72.50°W		VII(?)	CT Moodus - East Haddam
1592						41.50°N	72.50°W		VII(?)	CT Moodus - East Haddam
1627						42.60°N	70.80°W		VI(?)	MA Essex
1727	November	10	03	40		42.80°N	70.60°W		VII	MA Cape Ann
1737	December	19	03	30		40.60°N	73.80°W		VI	NY Southwestern Long Island
1744	June	14	15	15		42.50°N	70.90°W		VI	MA Cape Ann
1755	November	18	09	12		42.70°N	70.30°W		VIII	MA Cape Ann
1766	February	02				42.00°N	68.00°W		VI	MA Off Cape Cod
1783	November	30	03	50		41.00°N	74.50°W		VI	NJ Morris County
1791	May	16	13	00		41.50°N	72.50°W		VI-VII	CT Moodus - East Haddam
1800	December	25				41.90°N	71.10°W		VI	MA Wareham - Taunton
1853	March	12	07			43.70°N	75.50°W		VI	NY Lowville
1857	December	23	18	30		44.10°N	70.20°W		VI	ME Lewiston
1867	December	18	08	00		44.05°N	75.15°W		VI	NY Canton
1869	October	22	10	45		45.00°N	67.50°W		VI	ME Passamaquoddy Bay
1871	October	09	14	40		39.70°N	75.50°W		VII	DE Wilmington
1874	December	11	03	25		41.00°N	73.90°W		VI	NY Tarrytown
1884	May	31				40.60°N	75.50°W		VI	PA Allentown
1884	August	10	19	07		40.59°N	73.84°W		VI	NY Rockaway Beach
1895	September	01	11	09		40.70°N	74.80°W		VI	NJ High Bridge
1897	May	28	03	16		44.50°N	73.50°W		VI	NY Champlain Valley
1904	March	21	06	04		45.00°N	67.50°W		VI-VII	ME Passamaquoddy Bay
1905	July	15	10	10		44.20°N	70.00°W		V-VI	ME Sabbatus
1908	May	31	17	42		40.60°N	75.50°W		VI	PA Allentown
1912	December	11	10	15		45.00°N	68.00°W		VI	ME Eastport
1918	August	21	05	15		44.20°N	70.50°W		VI	ME Bridgeton - Norway
1925	October	09	14			43.70°N	73.10°W		VI	NH Ossipee
1928	February	08				45.30°N	69.00°W		VI	ME Milo
1928	March	18	15	25		44.50°N	74.30°W		V-VI	NY Saranac Lake
1929	August	12	11	24	49	42.84°N	78.24°W	5.3	VII	NY Attica
1931	April	20	19	54		43.50°N	73.80°W	4.7	VII	NY Warrensburg
1934	April	15	02	58		44.70°N	73.80°W		V-VI	ME Houghton
1940	December	20	07	27	26	43.87°N	71.37°W	5.6	VII	NH Ossipee
1944	September	05	04	38	46	44.97°N	74.85°W	6.0	VIII	NY Massena Center
1957	March	23	19	02		40.60°N	74.80°W	2.9	VI	NJ Schooley's Mountain
1957	April	26	11	40	09	43.54°N	70.26°W	4.0	VI	ME Portland
1963	October	16	15	31		42.70°N	70.80°W	3.3	VI	MA Off Cape Ann
1964	May	12	06	45	11	40.30°N	76.41°W		VI	PA Lancaster
1964	June	26	11	04	49	43.41°N	71.68°W		VI	NH Concord
1966	January	01	13	23	39	42.84°N	78.25°W	4.6	VI	NY Attica
1973	June	15	01	09	05	45.28°N	70.97°W	4.8	V-VI	ME Near PQ-NH border
1982	January	18	00	14	43	43.51°N	71.62°W	4.7	VI	NH West of Laconia
1983	October	07	10	18	46	43.94°N	74.25°W	5.3	VI	NY West of Newcomb
1984	April	23	01	36	02	39.95°N	76.32°W	4.1	VI	PA Marticville
1985	October	19	10	07	40	40.98°N	73.83°W	4.0	V-VI	NY Ardsley

Table 2: Damaging Earthquakes of Southeastern Canada, 1534-1988

Origin Time (GMT)						Epicenter			Epicentral	
Year	Month	Day	Hr	Mn	Sc	Latitude	Longitude	Magnitude (M_N)	Intensity (MM)	Locality
1534						47.70°N	70.10°W		IX-X	PQ Les Éboulements
1638	June	11	19			47.65°N	70.17°W		X	PQ La Malbaie
1661	February	10	12			45.50°N	73.00°W		VII	PQ South of Cranby?
1663	February	05	22	30		47.60°N	70.10°W		X	PQ La Malbaie
1665	February	24	16	45		47.80°N	70.00°W		VIII	PQ La Malbaie
1668	April	13	13	00		47.10°N	70.50°W		VI	PQ Ile aux Grues
1732	September	16	16	00		45.50°N	73.60°W		VIII	PQ Montréal
1791	December	07	01	00		47.40°N	70.50°W		VIII	PQ Baie-St-Paul
1816	September	09				45.50°N	73.60°W		VII	PQ Montréal
1817	May	22	08	30		45.00°N	67.50°W		V-VI	NB Passamaquoddy Bay
1831	May	08				47.30°N	70.50°W		VII	PQ Ile aux Coudres
1831	July	14				47.60°N	70.10°W		VII	PQ La Malbaie
1842	November	09				46.00°N	73.20°W		VI	PQ Montréal - Trois-Rivières
1860	October	17	11	15		47.50°N	70.10°W		VIII-IX	PQ Rivière-Ouelle
1861	July	13	02			45.40°N	75.40°W		VII	ON Ottawa
1864	April	20	18	15		46.90°N	71.20°W		VI	PQ North of Quebec City
1870	October	20	16	30		47.40°N	70.50°W		IX	PQ Baie-St-Paul
1872	January	10	00	54		47.50°N	70.50°W		VII	PQ Baie-St-Paul
1873	July	06	14	30		43.00°N	79.50°W		VI	ON Welland
1877	November	04	06	56		45.20°N	73.90°W		VII	PQ Howick
1883	January	01	02			45.00°N	67.00°W		VI	NB Passamaquoddy Bay
1893	November	27	16	50		45.50°N	73.30°W		VII	PQ Montréal
1897	March	23	23	07		45.50°N	73.60°W		VII	PQ Montréal
1897	March	28	03	14		45.50°N	73.60°W		VII	PQ Montréal
1908	August	08	12			46.30°N	67.60°W		VI	NB Hartland
1909	December	19	20			46.50°N	60.50°W		VI	NS Cape Breton
1910	February					48.00°N	70.00°W		VI	PQ North of St-Siméon
1914	February	10	18	31		46.00°N	75.00°W		VII	PQ Northeast of Ste-Adèle
1922	July	02	22	25		46.50°N	66.60°W		VI	NB Bathurst
1924	July	15	00	10		45.70°N	76.50°W		V-VI	PQ Shawville
1924	September	30	08	52		47.80°N	69.80°W		VII-VIII	PQ La Malbaie
1925	March	01	02	19		47.80°N	69.90°W	6.6	IX	PQ La Malbaie
1935	November	01	06	03	34	46.90°N	79.10°W	6.2	VII	PQ Témiscaming
1939	October	19	11	53		47.80°N	69.80°W		VI	PQ Ile aux Lièvres
1982	January	09	12	53	52	47.00°N	66.60°W	5.8	VI	NB North of Fredericton
1988	November	25	23	46	05	48.11°N	71.18°W	6.5	≥ VII	PQ Saguenay region

Table 3: Modified Mercalli Intensity Scale of 1931 (revised)

Level	Descriptors
I	Not felt, except by one or two persons lying down on the upper floors of tall buildings.
II	Felt by few or some. Described as slight or light.
III	Delicately suspended objects swung. Awakened few or some. Motion was described as swaying or slow. Felt by several. Felt quite noticeable indoors especially on upper floors. Felt by several or many indoors. Many people did not recognize it as an earthquake at first.
IV	Objects were disturbed. Frightened few; caused slight excitement. Motion was described as abrupt, sharp, jolting, or rapid. Hanging objects swung (no qualifying adjective used by observer). Felt by many. Felt by all in home or all in building. Felt outdoors by few or some. Dizziness or nausea was experienced by some. Dishes, windows, and doors rattled. Dishes and glasses knocked together on shelves. Walls creaked. Liquids in open vessels were disturbed. Awakened many or most. Awakened all in home. Noises like gusts of wind were reported. Described as moderate. Trees and bushes were shaken slightly. Direction of motion was noted indoors, or without specification of location (indoors or outdoors). Pendulum clock stopped, started, or changed rates markedly. Described as multiple shocks. Duration was estimated in minutes and seconds. Bumping sounds were reported. Motion was described as a rapid vibration.
V	Rumbling, thunderous, or subterranean sounds were reported. Hanging objects or doors swung generally or considerably. Described as strong. Trees and bushes were shaken moderately. Small objects were shifted from position; light furnishings were shifted from position. Pictures were knocked against the wall or swung out of position. Felt by practically all. Felt by most or almost everyone. Sensation similar to that of a truck striking the building was reported. Animals were frightened, stampeded, or broke out of their enclosures. Disturbances of poles and other tall objects were noted in some instances. Buildings swayed. Vibrations similar to those caused by the passing of a light truck were reported. Plaster was cracked. A few persons ran outdoors. Standing motorcars rocked.
VI	Liquids were spilled from containers. Roaring sounds were reported. Direction of motion was estimated by observers who were outdoors. Liquids were set in strong motion. Slight damage was incurred -- poor construction was sometimes specified. Small bells rang (church, chapel, school, etc.). Fire and burglar alarms were activated. Buildings trembled throughout. Many ran outdoors. Felt by all (without qualification). Felt by all in community. Many were frightened. Excitement was general with some alarm. Small unstable objects were overturned. Knickknacks fell. Some furniture of moderately heavy kind (chairs, tables, small sofas, small dressers, etc.) were moved from position. Objects were thrown from shelves and mantles. Merchandise was thrown from shelves in stores. Water or gas pipes were broken in isolated instances. Trees and bushes were shaken

Table 3: Modified Mercalli Intensity Scale of 1931 (revised) (Continued)

Level	Descriptors
	strongly. All were awakened. Plaster fell in small-to-moderate amounts. Chimneys were cracked. Some dishes, glassware, and windows were broken. Damage was negligible in well-designed structures and structures of good construction. Vibrations were reported comparable to those caused by heavy or heavily loaded trucks.
VII	Free-standing and exterior masonry walls were cracked. All were frightened. There was general alarm. Permanent or temporary changes in flow from springs and wells were reported; changes in temperature of water from these sources were noted. Well-built ordinary structures were damaged slightly to moderately. Cornices, brickwork, tiles, and stones fell from exterior walls and parapets of buildings. Several landslides were reported. Small quantities of rocks and boulders were shaken from hillsides and embankments in single instances. Chimneys were broken. Chimneys, with ratio of height above roof to lateral dimension at roof exceeding 5, were broken sharply at roofline. Wet ground cracked (no qualifying adjectives). Persons driving motorcars were disturbed. Noticed by persons driving motorcars. Some found it difficult to stand. Persons were made to move unsteadily. Sounds were reported similar to a sonic boom or an explosion. Electric power was interrupted. Water in streams and ponds became turbid and muddy. Waves were produced on ponds, lakes, reservoirs, and running water. Sand and mud shifted horizontally on beaches and flat land. Water was splashed on the banks of canals, lakes, rivers, etc. Water was thrown out of swimming pools and small ponds.
VIII	Free-standing walls and exterior masonry walls of buildings fell. Ordinary, substantial buildings were damaged considerably. Furniture was broken in some instances. Furniture was overturned. This includes that described as "heavy" as well as reports without qualifying adjectives. Waves were seen on surface of ground. Telephones were put out of service. Chimneys, monuments, factory stacks, etc., fell. Monuments were rotated on their bases. Doors and shutters were opened and closed abruptly (cabinet and cupboard doors included). Poorly built or badly designed structures were damaged greatly. Panel walls were thrown out of frame structures. Poorly built or badly designed structures sustained considerable damage. Railroad rails were bent slightly, moderately. Numerous windows were broken. Everyone ran outdoors. Free-standing solid stone walls were seriously cracked and broken. Trees and bushes were shaken violently. Trunks and branches were broken off. Underground pipelines were broken. Buildings swayed violently. Fill, railroad ballast, road beds, made land, and bridge approaches settled or subsided. Dishes and glassware were broken in considerable quantity. Some windows were broken. Specially designed structures sustained slight damage.
IX	Plaster fell in large amounts. Some stucco fell. Ground was cracked severely, with cracks several inches (centimeters) wide and fissures up to 1 yd (meter) in width. Ground was cracked conspicuously. Open cracks and broad wavy folds were formed in cement and asphalt pavement. Small buildings such as single-family frame dwellings were shifted on their foundations. Substantial masonry buildings sustained considerable damage with partial collapse. Sand and mud were ejected in small amounts. Sand blows and mud craters were formed. Dams, dikes, and embankments were seriously damaged. Reservoirs were damaged seriously, moderately, slightly. Sand or gravel on stream banks caved in to some extent. Earthflow, landslide, ruptures occurred. Earth slumps and land slips occurred in soft wet ground. Instances of slumping of river banks were numerous and

Table 3: Modified Mercalli Intensity Scale of 1931 (revised) (Continued)

Level	Descriptors
	extensive. Landslides were considerable from river banks and steep coasts. Very heavy furniture (stoves, refrigerators, large dressers, safes, etc.) were shifted from position conspicuously or overturned. Vertical faults of less than 5 ft (1.5 m) or without stated dimensions were reported. Alarm approached panic. Mole tracks were formed. Well-designed frame structures were thrown out of plumb. Masonry structures especially designed to withstand earthquakes sustained considerable damage. People were thrown off their feet, out of bed, or off chairs. Some well-built wooden structures were destroyed.
X	Concrete irrigation ditches were damaged considerably. Broad fissures were formed in ground. Foundations, cement floors, pavements, driveways, sidewalks cracked. Fences were displaced, torn apart or compressed. Underground pipelines were torn apart, crushed, or buckled. Objects were thrown vertically into air. Some well-built wooden structures were destroyed. Oil, gas, and water tanks were badly twisted or thrown down. Massive landslides occurred comparable in extent to the Madison River slide associated with the Hebgen Lake, Montana earthquake of 1959. Volume of slide material equaled or exceeded 35 million yd^3 (approximately 27 million m^3). Liquefaction of bearing soils caused buildings to sink into ground, sometimes vertically. Unequal liquefaction caused foundations to fail, tipping buildings on their side. Slopes failed, causing slumps and slides determined by analysis to have been caused by initial liquefaction of the subsoil.
XI	Severe compressions or extensions of the surface were reported. Tension cracks were produced. Pressure ridges were formed. En echelon cracks were produced. Lurch cracks were formed. Extensional fractures, open cracks, and fissures were formed. Horizonal faults and horizonal displacements were reported without amount of displacement given. Rails were bent greatly, and (or) were thrust endwise or buckled. Natural gas conduits were put out of service. Few masonry structures remained standing. Large, well-built bridges were destroyed. Bridge supports and abutments were damaged so badly that integrity of bridge was lost. Underground pipelines and conduits were put out of service completely. Dams, dikes, and embankments were split, breached, or severely damaged to the point were further failure was probable. Significant tsunamis were generated. Ground water was ejected in large amounts with geyser-like activity continuing for hours or days.
XII	Damage was total over an appreciable area, over four adjacent city blocks, over an area of 500-yd (0.5 km) radius, or over any area greater than this (for smaller areas, intensities of lesser degree should be assigned to individual structures). New faults were formed in formally competent crystalline rock. Water channels, streams, basins, aquifers were modified greatly. Rivers and streams were diverted into new channels or were dammed temporarily by offsets in their former channels.

REFERENCE

Brazee, R.J. (1979). Reevaluation of Modified Mercalli Intensity Scale for earthquakes using distance as determinant, *Bull. Seism. Soc. Am.* **69**, 911-924.

Boston Loss Analysis Study

by John Ebel
Assistant Director
Weston Observatory

Abstract

A Committee of experts established by Robert J. Boulay, Director of the Massachusetts Civil Defense Agency (MCDA), analyzed the potential for damage to the Boston Metropolitan area from a potential earthquake. This Committee, of which the author was a member, was composed of engineers, seismologists, and emergency managers. The primary task of the Committee was to review the Metropolitan Boston Area Earthquake Loss Study, prepared for MCDA by URS Consultants, Inc./John A. Blume & Associates, Engineers.

The potential for a damaging earthquake exists in the New England area, including a potential for earthquakes larger than that analyzed in the Loss Study (magnitude 6.25). Because of its concentrated population, building types and construction, the Boston area would probably suffer the most damage from an earthquake whose epicenter was in or near Boston. However, other cities throughout New England could suffer proportionately similar catastrophic damage from an earthquake epicentered in proximity to them.

The occurrence of a Richter magnitude 6.25 earthquake off Cape Ann, Massachusetts, a moderate size earthquake which has already occurred in the historic record, would cause damage in the range of 2 to 10 billion dollars(5 to 6 billion dollars being the best estimate) in the Boston metropolitan area (within Route 128) due to ground shaking, with significant additional losses due to secondary effects such as soil liquefaction, fires, and economic interruptions. Hundreds of deaths and thousands of major and minor injuries would be expected. Thousands of people could be displaced from their homes. Significant loss of functionality in some critical facilities such as emergency public facilities, radio and TV stations and medical facilities is also expected. Additional damage may also be experienced outside the Route 128 area, especially closer to the earthquake epicenter.

There are low cost, effective public education, mitigation and emergency preparedness measures that can and should be carried out which can reduce the loss of lives and property when an earthquake occurs in New England.

Executive Summary

A Committee of experts established by Robert J. Boulay, Director of the Massachusetts Civil Defense Agency (MCDA), has analyzed the potential for damage to the Boston Metropolitan area from a potential earthquake. This Seismic Loss Analysis Committee was comprised of widely respected engineers, seismologists, and emergency managers. Committee members included John Ebel, Ph.D., Edward Fratto, Katharine Kadinsky-Cade, Ph.D., Norton Remmer, P.E., Edward Thomas, Esq., M. Nafi Toksoz, Ph.D., and Kenneth Wiesner, P.E. The primary task of the Committee was to review the Metropolitan Boston Area Earthquake Loss Study (hereinafter referred to as "the Loss Study"), prepared for MCDA by URS Consultants, Inc./John A. Blume & Associates, Engineers (hereinafter referred to as "URS").

Table 1[5]: Summary of Damage and 72-Hour Post-Earthquake Functionalities Evaluation

Facility Group	Damage ($ Millions)	Damage Factor Range (D/RV, %)	Functionality Range (%)
Medical Facilities	96.5	2.1 - 15.2	14 - 26
Transportation Facilities and Systems	70.8	1.0 - 8.9	47 - 100
Gas and Petroleum Fuel Utilities	6.2	1.6 - 12.1	47 - 95
Water and Sewage Utilities	6.7	0.2 - 3.3	65 - 98
Electrical Power Utility	57.7	1.6 - 5.0	74 - 84
Communications Network	14.5	4.6 - 9.0	35 - 74
Emergency Public Facilities	9.7	3.3 - 14.4	16 - 26
Residential Building	2,500	2.3 - 10.0	57 - 62
School Buildings	992	0.7 - 15.5	11 - 19
Special Facilities:			
-- Dams	.095	0.4 - 1.3	69 - 72
-- Tall Buildings	390	10.3	27
Total	4,150		

[5] These figures and the accompanying report were submitted to Robert J. Boulay, Director of the Massachusetts Civil Defense Agency in February, 1990.

Nonstructural Earthquake Safety in Schools

by Virginia Kimball
Earthquake Safety Consultant

Abstract

After consideration of structural safety, the reduction of nonstructural earthquake hazards is the next step in reducing the risk of deaths, injuries, and costly earthquake damage in schools. Many nonstructural hazards such as furnishings, equipment, and stored items can be secured at little or no cost. Addressing the hazards posted by large windows and improperly stored hazardous materials can be more costly, but provides significant safety improvements and other benefits such as reduced fire and vandalism risk. Students, teachers, parents, custodians, and administrators should become aware of the need for nonstructural hazard mitigation to ensure an ongoing safety program in schools, with concurrent benefits to the community through reduction of hazards in the home and workplace.

Introduction

Identification and mitigation of nonstructural hazards in schools will reduce the risk of deaths, injuries, and costly damage when an earthquake strikes. Many of these hazards can be recognized and even corrected easily. Teaching students, staff, parents, and community members to be aware of earthquake hazards can be part of an ongoing earthquake safety education program which will make the entire community safer.

Definition

Nonstructural elements of the school buildings are those elements which are not part of the primary structure itself. These elements include ceiling tiles or suspended ceilings, light fixtures, windows, and furnishings.

Nonstructural hazards at schools include hazards in and around the school buildings and campus, as well as in the surrounding neighborhood. These might include electrical wires, underground pipelines, and nearby businesses which use or store hazardous materials.

Mitigation refers to actions taken to reduce the risk of damage or injury. For example, bolting a bookcase to the wall will prevent it from falling over during an earthquake; installing a fence or lip on each shelf will prevent the books from sliding off as the ground shakes. Moving a heavy box from on top of a cabinet and placing it on the floor is an example of mitigation with no cost and little effort.

Nonstructural Hazard Survey

The "hazard hunt" begins with a neighborhood survey, often assisted by fire department and city records. While these hazards are often impossible for the school to correct, emergency plans should consider many contingencies. Primary and backup evacuation routes and assembly areas must be located in the safest places.

Survey the entire campus and exterior of all buildings, noting parapets, overhangs, covered walkways, and other hazards which might drop during an earthquake. Heating and air conditioning units are often precariously installed above exits or in windows on upper floors.

Conclusion

Many nonstructural safety hazards are fairly easy to mitigate. Others require a great deal of time and/or money, in short supply at most schools. The risk of injury, death, and damage is significant, and while we cannot eliminate all hazards, we must do what we can to protect students and staff.

References

FEMA 74-Schools, "Identification and Reduction of Nonstructural Earthquake Hazards"

Non-Structural Earthquake Hazards Manual, FEMA

Videotape, "Reducing the Risks of Non-Structural Earthquake Damage in Schools," FEMA

Earthquakes K-6, A Teachers Guide, "Tremor Troop" curriculum, Unit 6, FEMA

Regional Safety/Emergency Response - Earthquake Safety of New England Schools

by Daniel Catlett
Earthquake Program Manager
Federal Emergency Management Agency

Abstract

This presentation focused on the philosophy of earthquake hazard education in schools and how it can complement the regional emergency response plan. Tangible suggestions for schools to initiate earthquake education programs were given including earthquake drills and the development of a useable emergency plan. Some resources for schools from the regional emergency preparedness office were also highlighted.

A Prototypical Earthquake Drill - A Critical Skills Exercise

by Sean P. Cox
Teacher, Salem High School

Abstract

Earth science students at Salem High School have participated in an environment of critical skills. Events are student centered, learning stresses both process and curriculum content, and the foundation for activity is problem solving projects. This particular project had students designing and rehearsing part of an emergency management plan (a hazard plan) responding to an earthquake affecting Salem, N.H. Students assumed roles of town officials in a three hour drill held in Salem's Emergency Operations Center (EOC). The drill was sponsored by the Town of Salem and the New Hampshire Office of Emergency Management. Project origin, planning, performance, and follow-up are detailed in this paper.

Introduction

For seven months, students in this class spent more than one hundred hours learning specific Earth Science topics, as well as learning strategies and how to work together. In March, as our plate tectonics unit progressed, the time to apply the curricular and process knowledge arrived. A project was designed with help from and in cooperation with our town's Emergency Management Director and the New Hampshire Office of Emergency Management.

Students were asked to design, document, and use a hazard plan that responded to an earthquake affecting the town. This plan could then be added to Salem's Emergency Management Plan. Students did extensive research and documentation preparing, not only the necessary plan, but also themselves, to play roles as decision makers in a disaster. The teacher, Emergency Management Director, and N.H. Office of Emergency Management, met and communicated numerous times to finalize details.

The actual drill, held in Salem's Emergency Operations Center (EOC), greatly surpassed all expectations. Students handled crisis after crisis in a three hour drill that included mass destruction, dam failure, utility outages, looting, hospital closings, and multiple evacuations. Groups of students rotated through three, one-hour shifts assuming roles such as school superintendent, reporters, and selectmen. There were times of confusion and near hysteria as a myriad of details crowded the EOC. Students struggled at times to prioritize and solve problems. However, all the participants and observers came away with a new respect for each other and the need to be prepared.

How It All Began

My personal teaching philosophy acknowledges that learning is complex. Learning is also different for each individual, and schools need to recognize these differences. Schools need to teach not only the "what," but also the "how." With this in mind, my ninety-six students were placed in a student-centered environment where they had the ultimate responsibility for their personal, as well as group, learning. Additionally, the students spent many class periods doing activities that gave them the opportunity to experience various learning styles. Projects created various concrete and abstract opportunities for the learners, including reading, writing, drawing, building, leading, organizing, researching, coordinating, prioritizing, and communicating.

Planning, Planning, and More Planning

The Director suggested a drill that would test the students' plan as a final evaluation of the project. This drill could satisfy my need to assess the students, and allow the town to benefit from a rehearsal of its emergency management plan. The teacher and the Director outlined the town's need for a specific hazard plan and discussed ways in which students might meet that need. A time and date for the drill was set, and a letter to the students was drafted, recognizing their recent experiences, and requesting their assistance.

The next task was initiating this fifteen day extravaganza by arranging for expert speakers to come to school. Issues discussed included seismology, engineering, hazard assessment, emergency response planning, and plan implementation. All of the speakers supplied printed materials to supplement their presentations.

On the first day, it was decided that the students needed additional guidelines to properly design a hazard plan. Plan design was separated into five areas: communication, evacuation, hazard assessment, private resources, and public resources. As the first few days passed, students struggled to prioritize the components of the problem and divide responsibilities. The teacher carefully guided students by questioning them and challenging them to use skills and knowledge previously acquired.

Meanwhile, the Director developed the script for the drill, provided the teacher with the roles and titles students would later assume during the drill (see list below), and secured access to a variety of resources. These resources included a college text, Federal Emergency Management Agency (FEMA) pamphlets, and a blank hazard plan illustrating plan design guidance. Telephone numbers of town department heads, state and regional emergency management personnel were also made available. Students also benefitted from a considerable amount of time and material from the New Hampshire Office of Emergency Management and its Natural Hazards Program Specialist.

List of EOC Town Officials and Staff Roles

Town Officials	EOC Staff
Chairman, Board of Selectmen	Message Loggers (2)
Members, Board of Selectmen (4)	Message Runners (2)
Town Manager	Update Status Board (1)
Emergency Management Director	Radio Communications (2)
Fire Chief	EOC Security (2)
Police Chief	EOC Logistics (2)
Public Works Director	Public Information Officer
Health Officer	Reporters (3)
Chief Building Inspector	
Director of Human Resources (Welfare)	
American Red Cross	
Superintendent of Schools	

As the project continued, I began to notice an increasing level of student anxiety and misdirection. Therefore, the Director and myself arranged for a project debriefing. The students presented their ideas and findings to a panel consisting of the Director, educators, and the New Hampshire Natural Hazards Specialist. This panel was able to give students valuable feedback on the plan's strengths and weaknesses. This day long debriefing also allowed the students the chance to look at the project critically.

Part II - Setting The Stage

At the beginning of the second week, student role sign-up was finalized. Students would assume these roles in a three-shift rotation. Students were to select a decision making role where they would play an active part in the Emergency Operations Center (EOC) and an EOC staff role or a role where they would be involved with rescue equipment and media presentations. They had to identify the shift during which they would begin a journal. This journal would be a record of the drill as well as an introspective analysis of the entire project.

The Director coordinated attendance of the town's department heads, school superintendent, American Red Cross representative, utility company representative, media, as well as state and regional emergency management officials. The Director and teacher finalized the details, including transportation payment, care of learning, physically, and motivationally disabled students, school and community rule implementation, lunch, and debriefing.

It Is D-Day

At 8:30 a.m. on D-Day (Drill Day), students anxiously gather materials and board the bus to Salem's EOC. Upon arrival at Salem's Main Street fire station housing the EOC, students hear building rules and consequences, leave their coats, and position themselves for the first shift. Once in place, Salem's EOC opens and the drill commences.

> *The EOC was opened in response to an earthquake at 7:50 a.m. measuring 7.5 on the Richter scale centered in nearby Hudson, N.H. With Salem's adult department heads as advisors, students enact their plan prioritizing needs, communicating with counterparts, and solving problems, all the while using the town's minimal remaining resources as judiciously as possible.*
>
> *The following is an excerpt from the drill script.*
>
> *"**SHIFT CHANGE - STATUS REPORT** - It is now 8:00 a.m. (the next morning).*
>
> *During the night, the public works department began repairs on the known broken water mains. The water towers are back up to capacity, but water service is provided to only a small portion of the town (Main Street/Depot area and Lawrence Road/Cluff Road area). The sewer system is completely out of service and sewage is beginning to leak into some streams and onto some roads. All power in town went out for most of the night and is beginning to come on in sections. Cable TV is still out. The cracks in the dam at Arlington Pond appear to be worsening.*
>
> *The evacuation center houses approximately 200 people who are in need of food.*
>
> *The police department spent a long night dispersing looters and making arrests. Approximately 20 people are in custody.*
>
> *The fire department responded to several building collapses, two house fires, numerous downed power lines, and 15 ambulance calls. Most of the patients were taken to a temporary first aid station.*
>
> *Two relatively minor aftershocks were felt during the night."*

Decisions are made, aid is rendered, and nerves are wracked as each shift struggles with a seemingly endless onslaught of high priority problems. At times, the EOC becomes a jumble of noise and confusion as internal communication deteriorates and priorities temporarily blur. Selectmen try to solicit information from the Building Inspector, only to find him occupied with both the Public Works and Health officials. Finally, the Emergency Management Director shouts loudly, quieting the din, returning the EOC to a semblance of "organization." After 180 minutes of emergency responses (simulating 24 hours), highlighted by a telephone call from the director of FEMA, the drill concludes with a press conference.

All are relieved, and excited, exhausted, and slightly saddened by the project's conclusion as they wait for lunch. Students share their shift disasters and responses. Some write feverishly in their journals. As the first of thirty pizzas arrive, students and staff alike enjoy a carefree lunch.

With the completion of the post-lunch clean-up, the group assembles for the anticipated critique and debriefing. Town and state emergency management officials have many kind words for the students followed by praise from Salem's Emergency Management Director and the teacher. In spite of the positive input, students decide that their hazard plan can be improved and request permission to keep the document for this purpose.

At 1:15 p.m., the students say their good-byes and thank yous. After a short ride, they're back in school, attending the last period class. These 96 fourteen and fifteen year-olds have truly had an experience of a lifetime, gaining a priceless perspective on their community and themselves.

Project Strengths and Weaknesses

Generally speaking, the project was far more successful than expected. Students were able to synthesize a plan for dealing with a natural disaster and put their plan into action. However, there were some specific areas of concern. Even though there were fifteen decision making roles (representing town officials) and another fifteen staff roles in the EOC, there were several students who had to double-up in order to participate in the EOC operation. Also, the EOC was very crowded with students, adult advisors, state and regional observers, and media.

The strengths were numerous. This activity was student centered. The group worked well as they researched and prepared the plan. On occasion, they met after school and weekends. Additionally, students had to make dozens of community contacts to gather materials and information. This resulted in positive public relations for both the school and the Town of Salem. Print media from Lawrence, MA and Salem, NH as well as TV news from Manchester, NH, covered the drill. Finally, the detailed journals conveyed that students wanted to do more. This gave all of us involved in the drill a real sense of accomplishment.

Hands-on, Minds-on Earthquake Education: Curricular Options and Shaky Activities

by Katharyn E. K. Ross
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National Center for Earthquake Engineering Research

Abstract

Knowing what to expect, how to prepare and respond to an earthquake is a proven method of mitigating loss of life and property. Teaching this knowledge is the responsibility of today's educators.

Effective earthquake education teaches students both earthquake science and safety, clarifies misperceptions, empowers the school community to realize they can survive a major earthquake, contributes to building a generation of earthquake-cognizant adults, and reduces future loss of life.

In order to initiate earthquake education programs, educators need to have information about available earthquake education materials and instructional techniques so that valuable time and resources are not spent redesigning what is already available, or so that information is not presented in an ineffective manner.

This presentation will provide a general overview of earthquake education curricula for grades K-12, and focus on important educational principles that will enhance the presentation of this material such as: consideration of prior knowledge, a psychologically supportive learning atmosphere, use of hands-on activities, use of critical thinking activities, and the integration of content throughout the curriculum in a Science, Technology, and Society (STS) program.

Introduction

As previously noted, earthquakes have damaged schools. Because children spend a significant portion of their day in schools, the school community needs to be well-prepared to meet school earthquake emergencies in order to protect the welfare of students and staff both during and after the ground shaking. What does this type of earthquake education program encompass?

- Awareness of seismic hazard and risk in a geographic area
- Accurate scientific information about earthquake-generating mechanisms
- Accurate earthquake preparedness and mitigation strategies

More specifically, earthquake education provides an opportunity to satisfy a number of goals in the areas of both science and safety:

1. Reducing loss of life and property damage in schools during earthquakes.

School Intervention Following a Critical Incident: Project COPE
FEMA 220. 20 pp.
How to Help Children After a Disaster: A Guidebook for Teachers. FEMA-219. 1991. 17 pp.
"Children and Trauma: The School's Response"
FEMA - Earthquake Education
500 C Street, S.W.
Washington, DC 20472

These materials focus on helping children and adolescents deal with disaster situations by 1) presenting background information on psychological stress due to emergencies; 2) providing teachers, school nurses, and administrators with methods to help both themselves and their students cope with such stress; and 3) suggesting pre-disaster planning measures that will alleviate much of the confusion that inevitably arises when adult authorities are not prepared to handle unforeseen crises. The School Intervention document was developed by a group of Project COPE (Counseling Ordinary People in an Emergency) clinicians and is based on their experiences in a crisis counseling program activated in response to the Loma Prieta earthquake. How to Help Children was designed by a team of Alameda County, California, educators and child mental health professionals as part of another post-Loma Prieta project. "Children and Trauma: The School's Response" is a 20 minute videotape to be used by teachers. All three items are free and can be obtained by writing to Marilyn MacCabe at FEMA.

Earthquake Education Curricula

School personnel are frequently unaware of existing earthquake education resources. As a result, money and time is spent trying to design something already available or easily adaptable. The following is a brief overview of earthquake education curricula currently available:

CALEEP Curricula
Lawrence Hall of Science

For grades 4 - 8

"Mini-Kit" consists of 14 Hands-On earthquake education activities:

a. Teacher's Guide - including blackline masters
b. Computer Disk - (Apple II+ and/or IIe with disk drive)
c. Filmstrip
d. Audio Cassette Tape - disc jockey, Mr. Pate, experiencing 1964 Alaska Earthquake
e. AAA map California

Await the Quake Game can be purchased through the Lawrence Hall of Science Eureka catalog.

I Can Make X the Difference
Chair
Emergency Preparedness Committee
Utah State PTA

For primary grades; written at 4th grade reading level

This contains a series of units on a number of areas involving emergency preparedness: fire, earthquake, flood, nuclear war, and weather problems. Each unit is set up in the same format and includes: an introductory poem; "What Would I Do" exercises; "Things I Should Know;" and games and puzzles. The earthquake section includes a map showing Utah earthquakes, an earthquake word hunt, and safety rules crossword puzzle.

Crustal Evolution Education Project available from: Ward's Natural Science Establishment, Inc.	Designed primarily for grades 7-12	Consists of 33 individual activity modules designed to provide students with an understanding "of the concepts behind plate tectonics and the physical Earth." Each module is individual, self-contained and designed for the Earth Science classroom. Modules include: "Locating Active Plate Boundaries by Earthquake Data," "Earthquakes and Plate Boundaries," "Plate Boundaries and Earthquake Prediction," "Hot Spots in the Earth's Crust," "Volcanoes: Where and Why?" and "Quake Estate," a board game to be played by two to four students whose goal is, "to achieve success in net income based on accuracy of assessing earthquake risks" (copyright, 1979). The CEEP is not intended to be a complete curriculum, but designed to supplement any teacher's curriculum.
Earthquake Awareness and Preparedness Curriculum Junior League of Oakland-East Bay	For pre-K-6; has been used with students up to 8th grade	This is a 1 hour curriculum that anyone can pick up and do that is particularly aimed at elementary students. There is a curriculum guide that provides lessons for each grade level, an Instructor's Guide from Environmental Volunteers, Inc., and role playing situations from CALEEP. There are also supporting videotapes that show each level of the curriculum that were prepared by JLOEB, the Albany Unified School District, and the Audubon Nature Training Society: preschool level, middle school, high school - adult (not included in the curriculum), and "School Facilitation."
The Earthquake Hazard Utah Publications Department Utah Geological Survey	For high school students	This is part of a larger curriculum called "Places with Hazards: A Teacher's Handbook on Natural Hazards in Utah" developed for secondary-level earth science teachers as a means of preparing students to live more safely in a world that can pose problems from natural hazards. Students should be able to make wise choices about where to live and work. The objectives are to learn about natural hazards, how they can be identified, what effects they have, and how they can be mitigated. Places in Utah are identified where natural hazards have occurred and can be expected to occur. The curriculum contains ten sections: 1) overview, 2) earthquakes, 3) slope failures, 4) problem soil and rock, 5) radon, 6) volcanoes, 7) avalanches, 8) wildfires, 9) floods, and 10) dam safety. Each lecture is accompanied by a set of 35mm slides for classroom use. Also included are activities, master sheets, glossaries, and resources.

Earthquakes: A Teacher's Package for K-6/FEMA 159 Marilyn MacCabe FEMA - Earthquake Ed.	For grades K - 6	This 280-page package was developed by the National Science Teachers Association. It contains hands-on classroom activities that support virtually all elementary subject areas. Designed for the classroom teachers with little or no background in earth science, the six-unit package focuses on: • Defining an earthquake; • Why and where earthquakes occur; • Physical results of earthquakes; • Measuring earthquakes; • Recognizing an earthquake; and • Earthquake safety and survival
Earthquakes (module) "Minorities in Engineering" Project	For grades 8 - 10	This is a module designed to interest students in earthquakes through activities, modeling, engineering applications, and simulation strategies. Has 12 lessons: 1-5 introduce students to earthquakes; 6-9 talk about observed precursors of earthquakes and introduces seismograms; and 10-12 try to make earthquake investigation relevant to students. Includes directions for making related items and doing experiments, i.e. making your own tiltmeter, creepmeter, shoebox model of a fault simulator and trying liquefaction simulation, resonating building demonstration, and earthquake simulation. Includes reproducible charts and maps. Can be used in part or total in an earth science or general science course.

Hands-On Earthquake Earthquake Learning Package Environmental Volunteers	For grades K - 12	1. Instructor's Guide a. 17 illustrated, plastic-protected Activity Folders b. 16 information/activity inserts (including quake myths, games, puzzles, math activity, "tremor tales"). c. Illustrated text on basic earthquake geology: The Story of the Earth d. Red Cross' Safety and Survival in an Earthquake e. "Getting Ready for a Big Quake" - Sunset magazine f. Complete guide to school earthquake planning g. Neighborhood Preparedness Guide h. "Plans for Teaching Materials" 2. Hands-On Teaching Materials a. Plate Tectonics Globe (removable plates) b. Earth Hemisphere Model c. Plate Puzzle map (ocean floor features) d. Wood Plate/Fault Blocks e. 9 ft. sq. plate tectonics rug (pattern also available) f. Sea Floor Basalt rock sample g. Sea Floor spreading box h. Time cards, markers and time-tape i. Continental Drift film (computer-generated) j. Fault Zone Model k. Magni-tube Model l. Motor driven shaking table and accessories
Northwest Earthquake Workshop for Teachers (N.E.W.T.) Pacific Science Center	Not organized by grade level	The goal of this curriculum is two-fold: to promote a better understanding of science processes through the investigation of Earthquake phenomena by providing conceptually sequenced, hands-on activities and to promote scientific literacy by encouraging the learner to develop and utilize the science process skills necessary for doing science and for living in a complex technological society.

Plate Tectonic Cycle - Earth's Moving Force Math/Science Nucleus	For grades K-6	Plate Tectonic Cycle - Earth's Moving Force (259 pp., 84 lesson plans including 28 innovative hands-on lab activities; 12/grade level K-6). Themes covered include volcanoes, earthquakes, plate tectonics, and hazards. Students learn that the Earth is dynamic as it spins on its axis, revolving around the Sun. The Earth is restless inside, as it tries to cool its interior. The crust of the Earth is pulled and pushed causing earthquakes and volcanoes along the boundaries of plates. Hands-on activities teach students how scientists investigate the Earth by looking at data derived from earthquakes and volcanoes and to think about present theories about why the Earth's surface moves. Learning about earthquakes and volcanic hazards will help children to understand disasters that sometimes occur and help them learn how to cope. Also includes a position paper on earthquake education, a section on developing a school-wide disaster plan, and a listing of organizations where more information can be obtained. This volume represents 4 weeks of a 34 week elementary science program per grade level called the Integrating Science, Math and Technology (I. Science MaTe) Program.

The Process of Learning

If lack of curricular resources were the only impediment to understanding earthquake education concepts, the presentation could end here. However, high quality materials do not guarantee learning. It is important not to confuse teaching and the presentation of materials with learning. There are other aspects of earthquake education, and indeed all education, that also need to be addressed.

First, there is the role of prior knowledge in filtering the information that is presented to children. Preliminary research indicates that current earthquake education, although helpful, may provide information that can be misinterpreted and misunderstood. In three related studies (Ross & Shuell, 1990a, 1990b), 91 students in grades K-6 from three different schools in two locations were interviewed to determine their beliefs about earthquakes. Even though each study included students who had learned about earthquakes in school, some of the students held misconceptions about earthquakes and what a person should do in the event of one.

The cause of an earthquake proved to be especially difficult for students. No student in the first study, less than 10% in the second, and about half in the third noted plate movement as a cause of earthquakes. Other responses included the earth's core getting too hot, faults, wind, loud noises, thunderstorms, drilling in sidewalks, heat from the sun on the earth, and lava.

Appropriate response in an earthquake was also difficult for students. The most frequently given answer for the K-3 group in the first study was, "I don't know." The grade 4-6 students in that study tended to answer they would go to the basement. No student in the initial study answered that a person should get under a desk/table, and less than a fourth replied that one should stand in a doorway. Students in studies 2 and 3 were more aware of that to do in an earthquake. Over half of them gave generally correct answers. However, further analysis of their answers indicated some possible conceptual difficulties. For example, in the second study, 40% of the fourth graders specifically mentioned metal when stating that one would be safe in an inside doorway. Additional questioning indicated that some children felt metal would protect them, rather than the structure of the building. As one student stated, "An earthquake doesn't do metal. It does concrete."

Recognition of the role of prior knowledge should guide instruction. Because children may have ideas about earthquake science, preparedness, and response prior to formal lessons, they may interpret what is taught in class in a different way from what was intended. Without knowledge of these preconceptions, (e.g., as metal is strong), teachers may not address them, and never realize that students have drawn different conclusions.

All of this points to the importance of assessment. If teachers do not assess, they do not know what students have learned. These measurement tools need not be elaborate but, they should avoid recall of rote information. Especially in science, students can often score a question correctly by looking for the answer that sounds "scientific." Words like "tectonic" can be such indicators. Figures 1 and 2 show examples of different kinds of evaluations using illustrations from Earthquakes: A Teacher's Package for K-6/FEMA 159 (Callister, Coplestone, Consuegra, Stroud, & Yasso, 1988).

Other aspects of learning that need to be considered are the addition of hands-on and minds-on (critical thinking) activities. Students should handle rocks and soil and be given activities where they have to critically evaluate information. This can especially be done in classroom activities involving building construction.

Finally, it is important to remember that introduction of content does not guarantee understanding of the topic, and oversimplification of difficult concepts may not give students enough information to take appropriate protective action in a variety of settings. In fact, students may respond in ways that could be dangerous.

Conclusion

Earthquakes remain a potential hazard, and tomorrow's adults must be provided with the skills to address and find solutions to the problems that will face us. They need to be aware of the dangers that earthquakes present to our communities and how to achieve a greater level of safety through building codes to ensure more earthquake resistant structures, training in earthquake safety actions to take during and after an earthquake, and improved levels of preparedness in schools, homes, and businesses. A comprehensive earthquake education program that considers the process of learning as well as the curricular materials, can provide insight into solving problems in science as well as make our environment a safer place to be.

References

Callister, J., Coplestone, L., Consuegra, G., Stroud, S., & Yasso, W. (1988). Earthquakes. Washington, DC: Fema-159.

Ross, K. E. K., & Shuell, T. J. (1990a, November). The earthquake information test: Validating an instrument for determining student misconceptions. Paper presented at meeting of the Northeastern Educational Research Association, Ellenville, NY.

Ross, K. E. K., & Shuell, T. J. (1990b). After Loma Prieta--what do children outside of California believe about earthquakes? Unpublished manuscript.

OBJECTIVE: Students will identify what is safe behavior during an earthquake and demonstrate this behavior during an earthquake simulation.

Look at the following picture to answer question 60.

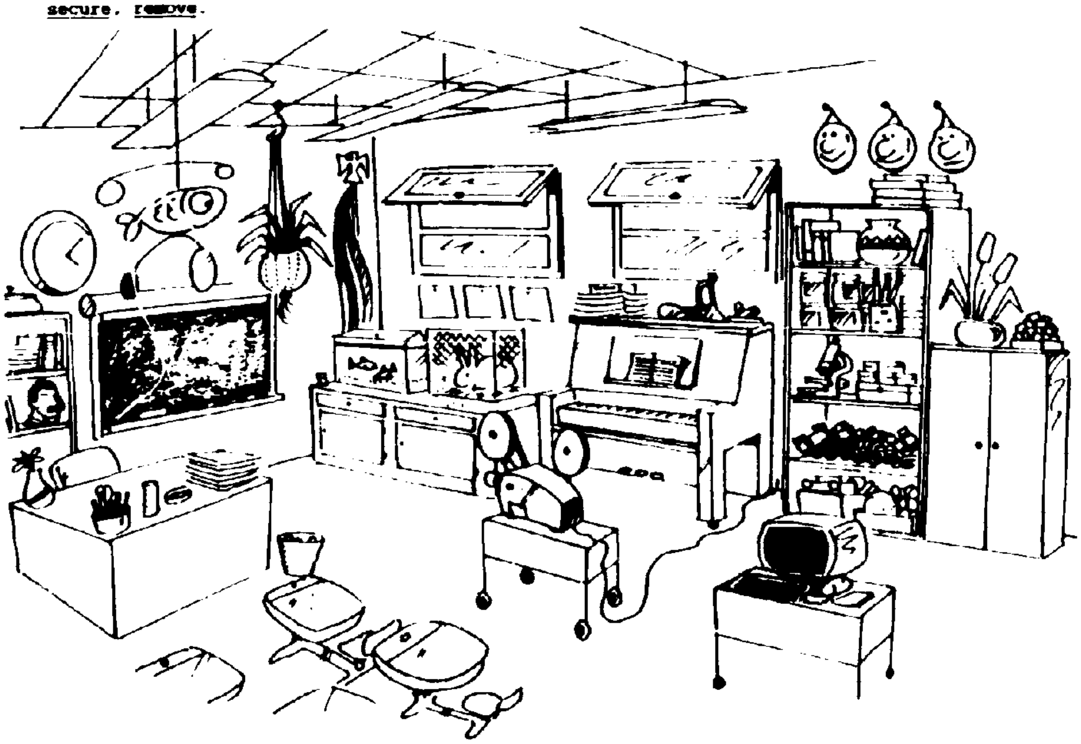
60. The only place to be in the event of an earthquake is in the inside doorway because earthquakes don't travel through metal.

a. This statement is correct and the reason is correct.
b. This statement is correct; the reason is correct but does not support the statement.
c. This statement is incorrect although the reason is correct.
d. The statement and the reason are both incorrect.

ABOVE RECALL

Figure 1: Example of Different Kinds of Evaluations Using Illustrations from Earthquakes: A Teacher's Package for K-6.

(Essay using vocabulary words from curriculum) Look at the following picture of a classroom. Tell how you could make it safer in an earthquake. Tell at least five ways using the following words: move, attach, fasten, secure, remove.



Possible answers could be:

1. Move heavy objects from the top shelf
2. Attach the book case to the wall.
3. Fasten the cabinet doors closed so they won't fly open
4. Secure the hanging plant with a closed hook.
5. Remove the aquarium from a place near to the students and teacher.

Figure 2: Example of Different Kinds of Evaluations Using Illustrations from Earthquakes: A Teacher's Package for K-6.

Part III

Education - Curricular Options

Integrating Earthquake Education in the Classroom

by Tori-Lynn Zobel
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Abstract

Earthquake education is just beginning to become relevant to schools and families in the northeast. Many assume that because we have not had a major earthquake in quite some time, the need to be educated in such a matter is unnecessary. However, with all the recent seismic activity in California, even people on the east coast are becoming aware of the disastrous effects of earthquakes and questioning a lack of preparedness.

By introducing earthquake education in the classroom, teachers are not only educating children, they are hopefully making families aware of the fact that the earth is always moving. Throughout the past five years, I have found that an earth science unit in the elementary school is a topic that children truly enjoy. They want to know more about the earth and discover why the ground is constantly changing. The unit is exciting for children. Their questions are endless.

Many new and interesting learning styles can be incorporated in teaching earth science in the elementary school. By involving the children with hands on experiences, activities that involve family input, and making resources constantly available to the classroom, the Earth Science unit is often difficult to end. Including earthquake awareness is an important aspect of this unit. It is also the part that children seem to be most interested in.

Introduction

Children's knowledge of earthquake education varies greatly. Some associate it with weather factors, while others have become interested in earth movement and seem to understand how the earth changes. Regardless of their backgrounds, children want to know more about the Earth. A whole language approach can integrate earthquake education into all subject areas.

Most recently, cooperative learning has become a major thrust in the classroom. This approach lends itself to group projects, discussions, and shared experiences and as such, is an exciting way to teach earthquake awareness.

As children collect data, a portfolio can be used by teachers and students alike. It often serves as a way to assess a child's work at the completion of a unit. Students often regard their folders as meaningful because they contain all the tasks they have completed throughout the unit of study. By making these tasks relevant to the children, a portfolio can become a more comprehensive evaluation of earthquake education concepts than a single test.

Text

The New York State Science Curriculum in the elementary school does not always include a unit on earth science. It may appear at the third grade level and then again at the fifth grade level. If a teacher strictly follows the syllabus, earth science does not appear to be a major unit at any level in elementary school. However, in high school, students are encouraged to take the Earth Science Regents course of study. Many register for a general science course and

During our weeks of study, I frequently grouped children and assigned them a specific task directly related to the earthquake unit. This style of cooperative learning is not a new idea. Johnson and Johnson (1991) define cooperative learning as "the instructional use of small groups so that students work together to maximize their own and each other's learning."[7] It is a very useful tool in teaching earthquake education. Student interaction is one of the key characteristics of cooperative learning. Recently, I divided a classroom of students into five groups to construct communities built on a fault. Each child had a specific task to complete, however the group had a mutual goal - building the community. After the groups completed their assignment, they did a verbal presentation for the other members of the classroom. Students discussed the construction of their communities before and after an earthquake.

Evaluating a student's progress is probably one of the most difficult facets of teaching. One of the current directions in evaluation is portfolio assessment. It is used quite frequently in language arts and reading, however when utilized in science, portfolio assessment can be a valuable tool for a teacher. "The concept behind portfolios is a powerful process that serves the students and guides the teacher."[8]

Frequently at the beginning of the earthquake unit, I have children make their own folders complete with a table of contents. As we work through activities, writings, experiments and presentations, the contents of the folders grow. Students are encouraged to review their work and even re-do it if they feel it could be improved. At the end of the unit, I designate a date that all folders must be handed in. At any time, work can be added to the folder, thus the table of contents can also grow. I frequently review its progress with the children before it is handed in for a grade. It amazes me to see the pride most students take in their portfolio. They really seem to care about what's inside that folder.

Teaching earthquake education and awareness to children involves many styles of presenting materials. Children are anxious to learn about their planet, how it is ever changing, and how to cope with the dangers of a disaster. Including earthquake education at all levels provides continual growth for students and teachers alike.

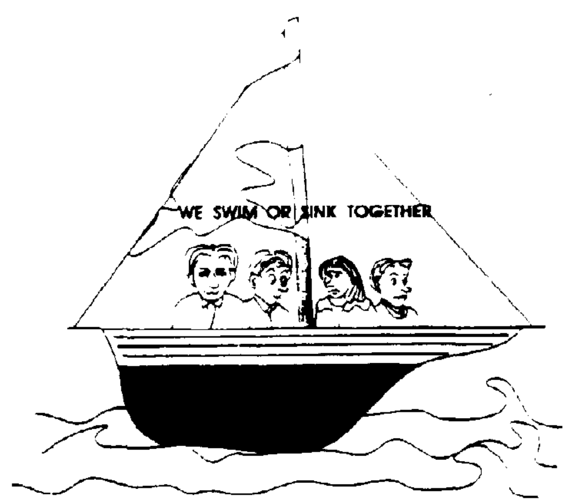

Figure 2: Our responsibility is to achieve a cooperative relationship.

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[7] Cooperation in the Classroom - Revised, David W. Johnson, Roger T. Johnson, Edythe Johnson, Holubec, 1991.

[8] Invitations: Changing as Teachers and Learners K-12. Regie Routman, Portsmouth: Heineman, 1991.

Selected List of Readings on Earthquakes

Picture Books

Mary Elting, *Volcanoes and Earthquakes*, Simon and Schuster, 1990.

Keith Lye, *Our Planet the Earth*, Lerner Publications, 1980.

Donald M. Silver, Ph.D., *Earth: The Ever-Changing Planet*, Random House, 1989.

Seymore Simon, *Earthquakes*, Morrow, 1991.

Philip Whitfield, *Why Do Volcanoes Erupt?*, Viking, 1990.

Adult Books

Bruce Bolt, *Earthquakes: A Primer*, W.H. Freeman, 1978.

G.A. Eiby, *Earthquakes*, Van Nostrand Reinhold, 1980.

James M. Gere and Haresh C. Shah, *Terra Non Firma*, W.H. Freeman, 1984.

Frederic Golden, *The Trembling Earth*, Scribner's, 1983.

Pierre Kohler, *Volcanoes, Earthquakes, and the Formation of Continents*, Barron's, 1986.

Susanna van Rose, *Earthquakes*, Her Majesty's Stationary Office for Institute of Geological Sciences, 1983.

Bryce Walker, *Earthquake*, Time-Life, 1982.

Misconceptions in the Options Available to Earthquake Educators

by Jeffrey C. Callister
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Abstract

Misconceptions about any information area waste valuable resources like time and money. In earthquake education, misconceptions can also result in added injuries and deaths. Earthquake educators have many resources available to them as background material and for direct use in the classroom. These resources include printed news media, broadcast media, textbooks, journals, and video tapes/films. Through my years of earth science and earthquake education, I have identified many misconceptions that pervade the educational resources. These misconceptions include the following:

1. Most big earthquakes involve ground shaking of many minutes;

2. The use of the term tidal wave to mean tsunami and the belief that tsunami phenomena include high waves on the open ocean;

3. The descriptions of the Richter scale which confuse its method of measurement and magnitude energy differences;

4. The misuse of the terms crust and lithosphere especially related to crustal plates versus lithospheric or tectonic plates.

A description of these misconceptions, examples of the use of these misconceptions, and the effect of these misconceptions on earthquake education will be presented. A need exists to identify other misconceptions. A concerted effort should be made to keep the misconceptions out of materials available to educators and thus, the population they influence.

Background

To find fault (not in the earthquake sense) is one of the easiest endeavors of humans. We often seem to get the greatest thrill when someone else, especially someone in an influential position, makes even the slightest mistake. A recent example is the spelling of "potato" by our Vice President. But, when the mistakes reflect common misconceptions about a potential hazard such as earthquakes, the result can be an incorrect response.

Throughout my 28 years of high school and college teaching, I have identified some pervasive misconceptions in the available resources. This study has forced me to list, document, and attempt to explain the problems these misconceptions can cause. These misconceptions include the following:

1. Most big earthquakes involve ground shaking of many minutes;

2. The use of the term tidal wave instead of tsunami and the belief that tsunami phenomena include high waves on the open ocean.

3. The descriptions of the Richter Scale which confuse its method of measurement and magnitude energy differences;

4. The misuse of the terms crust and lithosphere especially related to crustal plates versus lithosphere or tectonic plates.

Literature Research Method

It was decided to search for the above listed misconceptions in a series of materials available to typical students and teachers. These materials included:

1. A daily (Times Herald Record) and national newspaper (New York Times) for the time period from 1980 to the present.

2. A national news magazine (Time) from 1980 to the present.

3. Twelve earth science text books commonly used throughout the United States for the last ten years in secondary schools - grades 7 through 12 (see references).

4. Two old "classic" secondary level earth science texts (Namowitz & Stone, 1975; Ramsey, Burckley, Phillips, & Watenpaugh, 1973).

5. Two college earth science / geology texts commonly used throughout the United States (see references).

These materials were searched using the key words continental drift, crust, earthquakes, geology, lithosphere, plates, plate tectonics, Richter scale, tidal waves, tsunami, and waves. An attempt was made to list various sections of the materials that contained any of the misconceptions listed above. However, the specific source will not be mentioned. We cannot change the past but only point the direction for a better future.

Examples and Importance of Misconceptions

1. **Most big earthquakes involve ground shaking of many minutes.** One of the best and most interesting descriptions of the short time of earthquake shaking was for a 7.5 Richter earthquake in Algeria in 1980. "Everything happened so quickly. The dogs did not have time to bark." Only one example was found of this misconception in the literature search. One of the newspapers describing a New York State earthquake stated, "The arthquake had its epicenter there at precisely 46 seconds after 6:18 a.m. and lasted about 7 minutes." In working with many student groups, I have found that high school and college students in the Hudson Valley of New York commonly feel that most earthquakes involve felt ground shaking of many minutes despite their having felt ones lasting only 10 to 20 seconds. The Alaska quake of 1964 and the Mexico City quake of 1985, which were some of the longest shaking quakes, caused felt shaking of about four minutes.

   One problem with this misconception is that if individuals think that the felt shaking has a long duration, they may try to get out of the building, car, or other location they are in, as opposed to getting under the nearest strong object. In trying to "escape" from a building during an earthquake, individuals can expose themselves to more dangerous hazards from the outside and inside edges of buildings.

2. **The term tidal wave is used to mean tsunami and the belief that tsunami phenomena include high waves on the open ocean.** Many examples of various types of misuse of the word "tidal wave" instead of "tsunami" were found in the newspapers and magazines. Examples include:

    - "The strength of the quake set skyscrapers to swaying as far north as Houston, 1,100 miles away from the epicenter. A two-ft. tidal wave rolled ashore on the coast of El Salvador...Hawaii...was alerted to prepare for an ocean swell known as a tsunami, but it never materialized."

    - The..."quake generated a tsunami, but the tidal wave was only a little over a foot high when it reached Yakutat on coast."

    - "But a warning of a tsunami, or large wave popularly known as a tidal wave, was not issued."

    - "The quake also shook all of northern Honshu...but it caused no tidal waves a spokesman said."

    - "A severe earthquake caused minor damage in two Alaska towns but was not strong enough to generate a tidal wave...The Alaska Tsunami Warning Center canceled a warning of a tidal wave that was issued for part of the Alaska coast..."

    - "Tsunamis are often called tidal waves, but they have nothing to do with tides."

    There seem to be no similar examples from textbooks. Popular media often use "tidal wave" and "tsunami" synonymously or, they often only use the term tidal wave when they should be writing "seismic sea wave" or tsunami. No evidence was found related to tsunami waves being very high on the open ocean like that indicated in the movie, "The Poseidon Adventure." Some ancient Greeks may have thought the god Poseidon had the power to cause earthquakes but hopefully not very high waves on the open ocean. It was nice to see a tsunami newspaper report in 1986 that stated "In Honolulu as well as in other cities with harbors opening to the sea, most of the small boats and almost all ships moved out to deep water to await the wave, where it is usually small."

    The problem with confusing "tidal waves" with tsunami is that most people have experienced tides and they know that tides are a slow up and down movement of the ocean water associated with normal water waves. Probably the closest approximation of a "tidal wave" acting like a tsunami are the tidal bores found in some harbors and estuaries. These tidal bores move at 10 to 15 km/hr compared to the 500 to 600 km/hr speed of tsunami. Tsunami waves can reach heights up to 160 km and greater, significantly more than the meter or less height of a tidal bore! Since tsunami are rare on most ocean shores, if there is a warning, many people may not move to high ground, thinking the tides and associated events are not dangerous. With the increased mobility of many Americans, especially to Pacific shores, quick response during a tsunami warning can easily affect life or death.

    Discussions with many students indicate that there is a commonly held belief that tsunami waves are very high when they are on the open ocean in deep water. In fact, tsunami waves are less than a meter above the normal ocean level in deep water. Up to this time, I have found no evidence in print to lead to this misconception. This misunderstanding could also result in extra injuries and deaths during a tsunami warning. An individual in charge of a boat might easily steer for shore instead of the open ocean.

3. **The descriptions of the Richter scale confuse its method of measurement and magnitude energy differences.** In every type of source investigated, except for college texts, there are voluminous examples of incorrect and/or misleading descriptions of the Richter scale of earthquake magnitude. Richter himself states

"Misinterpretations of the scale are frequent. The hardest to combat is the assertation that magnitudes are 'on a scale of ten,' a fossil preservation of the Rossi-Forel intensity scale." (Richter, 1958, p. 353) The Rossi-Forel scale is similar to the modified Mercalli intensity scale commonly used today.

Some examples from secondary school textbooks are:

- "The Richter scale rates earthquakes from 1 to 10 according to their magnitude."
- "The higher the number, the stronger the earthquake."
- "An increase of 1 in magnitude on the scale indicates the release of 10 times the energy of the next lower number..."
- "Each number represents an earthquake that is ten times larger than an earthquake represented by the preceding number."
- "Each number indicates a release of energy about 60 times greater than the preceding number."
- "Each of the numerical steps in the Richter scale represents a ten-fold increase in the amount of energy released."
- "The Richter scale uses number from 1 up to describe earthquake magnitude. Each number indicates an earthquake ten times stronger than the next lower number."

Some examples from newspapers and magazines are:

- "The tremor struck at 1:29 a.m. and registered about 2.5 to 3 on the Richter scale of ground motion and energy release."
- "A light earthquake rattled parts of southern New Hampshire today as Democratic and Republican Presidential candidates arrived...The tremor...was recorded at a preliminary magnitude of 2.6 on the open-ended Richter scale."
- For a January 1992 earthquake felt in New York City, a source stated, "The Richter scale measures ground motion with each point signifying a tenfold increase."
- In relationship to a Richter 3.0 earthquake very near the Indian Point nuclear power plant in Peekskill, NY in 1980, "The plant, the spokesman said, was built to withstand 'an intensity of 7 on the Mercalli scale,' which is also related to the Richter scale's measure of absolute force, but is modified 'to measure potential for damage....One of the arguments made by antinuclear advocates who have long sought closure of the Indian Point plants is that they are located directly over a branch of the Ramapo Fault, a major fracture in the earth's crust."
- In a report of New Brunswick earthquake in 1982, it was stated, "The Jan. 9 earthquake was rated 5.9, making it the strongest quake in the East for a century. The magnitude indicates the amount of energy released as recorded in ground motions."

- "The Richter scale is a measure of ground motion as recorded on seismographs. Every increase of one number means a tenfold increase in magnitude. Thus a reading of 7.5 reflects an earthquake ten times stronger than one of 6.5."

The above examples reflect varying degrees of correct or incorrect beliefs about the Richter scale. It is true that when the Richter scale is computed from seismograms that each tenfold increase in ground motion, as reflected in seismic wave amplitude, indicates an increase of one whole Richter magnitude number. The problem is that an increase in one whole Richter value represents about 31 times more energy, not ten times more energy. Multiples of 31 end up making earthquakes in the 7 or 8 range much more powerful, than multiples of ten would. "This points up the interesting fact that the few large earthquakes each year release more seismic energy than the hundreds of thousands of small shocks combined." (Press & Siever, 1985, p. 453.).

When the population, led by the textbook authors/publishers and the press are misinformed about increases in energy with increasing Richter values, they could easily fall into the trap that many small earthquakes in an area could relieve the pressure in the area's rocks/faults. If an area has many low Richter value earthquakes, this can lead to the unsubstantiated belief that the "big one" will not come, or that the "big one" has been pushed off into the far distant future. Much, if not most of the United States needs to be considerably more prepared for earthquakes. They could be lulled into a false sense of security by incorrect knowledge of the Richter scale.

4. **The misuse of the terms crust and lithosphere especially related to crustal plates versus lithospheric or tectonic plates.** Again, in all types of sources, except for the college texts, I found numerous places where "crust" or "crustal" was used in conjunction with "plates" or "plate tectonics." The plates of the Earth move on the asthenosphere and not the Moho, thus plates are lithospheric in thickness. Plates should be described as plates, tectonic plates, or lithospheric plates, NOT crustal plates or continental plates.

   Some quotes from secondary textbooks include:

   - "Each of these giant crustal plates is slowly sliding over the earth's surface at different speeds."
   - "Plates are rigid sections of the earth's crust."
   - "We can see now that the old term, continental drift, is no longer useful. This is because the plates are made of both continental and oceanic crust. But, the continents are carried on crustal plates."
   - "According to the theory, the earth's crust is like the shell of a cracked egg. The crust is cracked in many places. The cracks divide the crust into about 20 pieces. The pieces are called crustal plates."
   - In one text, there is a section titled "Crustal Plates in Motion" and then under that heading it says..."The lithosphere is divided into plates."
   - "The discovery of sea-floor spreading showed that sections of the earth's crust did not move...Some plates are made up almost wholly of oceanic or continental crust."
   - "The hypothesis of plate tectonics suggests that the entire surface of the earth is covered by a small number of vast blocks or plates of lithosphere (rock)."

A few examples from newspapers and magazines include:

- "Solid though it appears, the earth's crust is composed of a dozen large plates and several smaller ones, ranging in thickness from 20 to 150 miles. ...As the Cocos plate dips under the continental crust" (referring to the North American Plate).

- "This belt straddles the area in which the Arabian tectonic plate of the earth's crust is grinding gradually northeastward..."

- "The frequency of quakes on the West Coast results from the fact that California is at the boundary of two of the earth's tectonic plates, the huge, inexorably moving masses upon which the plate's continents ride."

- In a September 1992 publication, "The theory of plate tectonics says quakes should happen most often along the edges of crustal plates, pancakes of rock a few score of miles thick and thousands of miles across, which carry the continents on their backs as they slide across the semimolten mantle below."

The misconceptions caused by the misuse of crust or crustal instead of more accurate descriptions of the plates may not cause any more injuries or deaths in an earthquake or other natural hazard. It may be just a pet peeve of mine that illustrates the need for more accurate editing of the materials students of the earth are exposed to. The big point is that plates are lithospheric in thickness and I feel that the term lithosphere has much more importance in a modern plate tectonic model, thus, the use of the word "crust" should largely be discontinued. The problem is that the crust, mantle, outer core, inner core model of the Earth is easier to teach, diagram, and describe as compared to a model which includes (at least in part) the lithosphere (including the crust at top), mantle (with various parts including the lithosphere below the crust and the asthenosphere), outer core, inner core. It is also difficult to convince editors and publishers to use a more complicated model, even if it is more accurate.

Conclusions

Of the numerous conclusions I could make, the most important one is that the authors, editors, publishers, etc. that control the production of the resources available to the schools and the public in general, should be more accurate in their descriptions of earthquake related events. There are many other examples of descriptions used by the media and textbook publishers that can lead to misconceptions. A few of these follow:

- Confusion between the Mercalli intensity scale and Richter magnitude scales; mixing up the concepts of intensity versus magnitude related to earthquakes.

- An overabundance of discussion about body waves (P-waves and S-waves) to the exclusion or very limited discussion of the surface earthquake waves (Raleigh and Love). It is the surface waves that cause most, if not nearly all, the damage at the earth's surface during an earthquake.

- Newspapers and magazines use many different words to mean an earthquake, including microquakes, quakes, seismic event, shock, tremblor and tremor. How many different types of earthquakes are there in the minds of the populace of the United States as a result of this terminology?

I am sure that there are many other problems I have not listed that can result in misconceptions. Some misconceptions have only, or largely only, scientific interest, like the "crustal" discussions of this paper, but confusion and misinformation can result in added injuries and deaths when earthquake information is misunderstood.

If I had more time, I would have included movies, films, video tapes, television programs, filmstrips and slide sets in this study. I have viewed many earthquake audiovisuals and some make me just yell out in the middle of them with comments like, "Where were the educators, seismologists, science editors and the like when these products were being produced?"

Some national organization(s), government agency(s), and/or educational institution(s) need to educate and put pressure on the producers of the information about earthquakes. Maybe just some letters to the editors, producers, and publishers would help. Any other suggestions?

Acknowledgments

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Hands-on Earthquake Education at the New York State Museum

by Gary N. Nottis
Research Scientist, Seismology
Geological Survey, New York State Museum

Abstract

In February 1992, the author and an assistant offered the first hands-on earthquake workshop for adults at the New York State Museum. There were 15 participants ranging in age from 40 to 90 years. The workshop was given in two parts. "Earthquakes: The Basics" was the title of the first part, and it took place over a two-hour period on a Saturday morning. The following topics were discussed: (1) what are earthquakes? (2) why do they occur? (3) where do they occur? (4) how do seismographs work? (5) how are earthquakes located? and (6) how are their sizes determined? A balance was maintained between lecturing, giving demonstrations, and involving the participants in hands-on demonstrations and activities. Workshop participants received packages that contained listings and brief explanations of the concepts covered under each topic, along with appropriate illustrations. Also included in the packages were lists of suggested readings and phone numbers where people could call for information about local and global earthquakes. all materials were prepared for a 9th grade reading level. Each participant was invited to take part in several hands-on demonstrations. Most of the ideas for the demonstrations were taken from Earthquakes: A Teacher's Package for K-6 (a.k.a. "The Tremor Troop"). For the activities, each participant located and determined the magnitude and felt intensity (MM) of a local earthquake that they all had experienced. A discussion of their results followed. The second part of the workshop took place on the following Saturday morning, and it also lasted two hours. This part of the workshop was titled "BIG SHAKES in New York State." Topics discussed included: (1) differences between events in California and New York, (2) earthquake history of New York, (3) speculations about future earthquake activity in or near New York, (4) governmental preparedness activities, (5) personal preparedness, and (6) the emotional impacts of earthquakes. All participants received packages like those given in the first part of the workshop. Several FEMA and Red Cross publications on earthquake and general disaster preparedness were included in the packages. The highlight of this part of the workshop was an earthquake hazard hunt through the New York State Museum. A review of the topics from the entire workshop was given at the Museum's permanent seismology exhibit. Evaluation forms completed by the participants indicated that the workshop was a great success. Each participant noted that the teacher's enthusiasm, clear answers to questions, and prepared materials were key to the success of the workshop. An expanded workshop for adults and students of grade 7 and up will be given at the New York State Museum in October, 1992.

Introduction

The hands-on earthquake workshop was inspired by:

- Need for public education about New York's earthquake hazard
- Hot-and-cold official support for such education
- Missed educational opportunities

- Deaths of Tara Leaton and Travis Franck

The goals of the workshop were to:

- Educate the public
- Inspire and train others to teach
- Learn how to write appropriate educational materials

This workshop was given:

- With facilities support
- Without financial support
- Using free educational literature
- Using "at-hand" and "throw-away" materials
- On the strength of the instructor's and assistant's enthusiasm

Workshop Program

"Earthquakes: The Basics" was the title of the first part of the workshop program. It included the following topics:

- What was that?
- Recipe for an earthquake
- Some words about waves
- Anatomy of an earthquake
- "Where the quakes are..."
- Catching waves
- Tracking tremors
- How BIG was it?
- "...of varying degrees of intensity (MM)."

Part III - Education - Curricular Options

The second part of the workshop took place a week later. Titled "Big Shakes in New York State," this workshop included:

- East verses west
- Past and present quakes
- "The tea leaves say..."
- "What if..."
- Governmental activities
- "An ounce of PREVENTION..."
- "BIG WORLD, small me."

Participants received packages containing the following:

- Concept outlines with illustrations
- Lab materials
- Glossary
- Suggested reading lists
- Earthquake information phone numbers
- FEMA and Red Cross Publications

Conclusion

There were a number of elements that made these workshops a success:

- Teacher enthusiasm
- Balanced presentation
- Message of hope
- Material presented for 9th grade reading level
- Hand-outs
- Clear and direct answers to questions

In the future, the following improvements are being considered:

- Simplify earthquake location lab
- STOP units for concepts hand-outs
- Large doll house displays for home hazard hunt
- Displays of home preparedness items
- Models to show community hazards
- Pictograms for graphics when possible
- Color slides rather than overheads


I felt like I couldn't do any thing about it
BIG
WORLD
small
me

The Center for Earth Sciences and How it Can Facilitate Earthquake Education

by Mark Shoengold
Assistant Director, Center for Earth Scier· es
Kean College

Abstract

The Center for the Earth Sciences is located at Kean College in Union, New Jersey. As part of its commitment to promoting earth science education, the Center maintains a resource room containing teaching materials and generates activities relating to the earth sciences. The Center has taken an active interest in natural hazards, including earthquakes. A conference on such hazards was held and follow up courses and workshops are planned. Through similar activities, college centers can act as catalysts for earthquake education in the schools.

Multi-Hazard Conference Ushers in International Decade

Approximately 70 educators attended a multi-hazard conference in New Jersey, November 15-16, 1991. "Natural Disasters: Before, During, and After" was held at Kean College, New Jersey and sponsored by the Center for the Earth Sciences at Kean College, New Jersey and the National Center for Earthquake Engineering Research. Public Service Electric and Gas Company and Jersey Central Power and Light Company were co-sponsors of the event which was held in cooperation with the American Red Cross and the New Jersey State Police, Emergency Management.

Sessions at the two day conference included scientific and preparedness information as well as classroom activities about earthquakes, hurricanes, urban flash flooding, land subsidence, severe storms and tornadoes, severe winter conditions, volcanoes, sea level rise, and psychological aspects of tragedy. Earthquake sessions included "Earthquakes in the Northeast" given by Dr. Klaus Jacob, Lamont-Doherty Geological Observatory; "Earthquake Curriculum" given by Dr. Joyce Bagwell of the Earthquake Education Center, Charleston Southern University; and "Children's Beliefs About Earthquakes: Addressing Misconceptions" given by Katharyn Ross of NCEER. Dr. Walter Hays, of the United States Geological Survey, addressed volcanic hazards and stressed the need for the following factors to come together to help with natural disasters: Social, Technical, Administrative, Political, Legal, and Economic.

Plans for the Future

A series of environmental debates were initiated in Fall, 1992. Along with these debates a short course for teachers on "Debates As a Teaching Strategy" was added in Spring 1993, to the schedule of activities. This course is participatory in nature, exploring the possibilities of debates and role playing in making students more active participants in the learning process.

Recorder Notes
Education - Curricular Options

by Katharyn Ross, Discussion Facilitator
National Center for Earthquake Engineering Research

Mark Worobetz, Recorder
New Jersey Earth Science Teachers Association

1. How do we get earthquake education into the schools?
   - How do you get the administrators to get involved?
   - Should principals be questioned about disaster response?
   - Should earthquake education be in the schools?
     (with our mobile society, everyone will eventually be in the area of greater earthquake danger)

2. How do you sell safety and science?
   - Do you teach it all together or separate issues? (Whole Language Approach with an earthquake - theme is one way to integrate it).

3. How can earthquake education facilitate learning outside the classroom?
   - Have students take home lessons and teach the parents
   - Have students talk to grandparents about past events

4. What is the correct response time in an earthquake in environments outside of the classroom? In a hotel? In a subway?

Recurrent Theme in the education discussion:

- Importance of community involvement
- Adding safety to science
- Multi-disciplinary - interdisciplinary program
- Importance of learning outside the classroom

One of the issues discussed during this period of time was the use of duration magnitude. The following is further information on this topic provided by Gary Nottis.

Duration Magnitude (M_c)*

- *Coda-length* normally refers to time, in seconds, of an earthquake's signature on a seismogram, extending from the *S-wave* arrival to the point where the signal has faded into the background of the seismogram.

- *Duration* refers to time, in seconds, of an earthquake's signature on a seismogram, extending from the *P-wave* arrival to the point where the signal has faded into the background of the seismogram.

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* Information on duration magnitude provided by Gary Nottis, New York State Geological Survey.

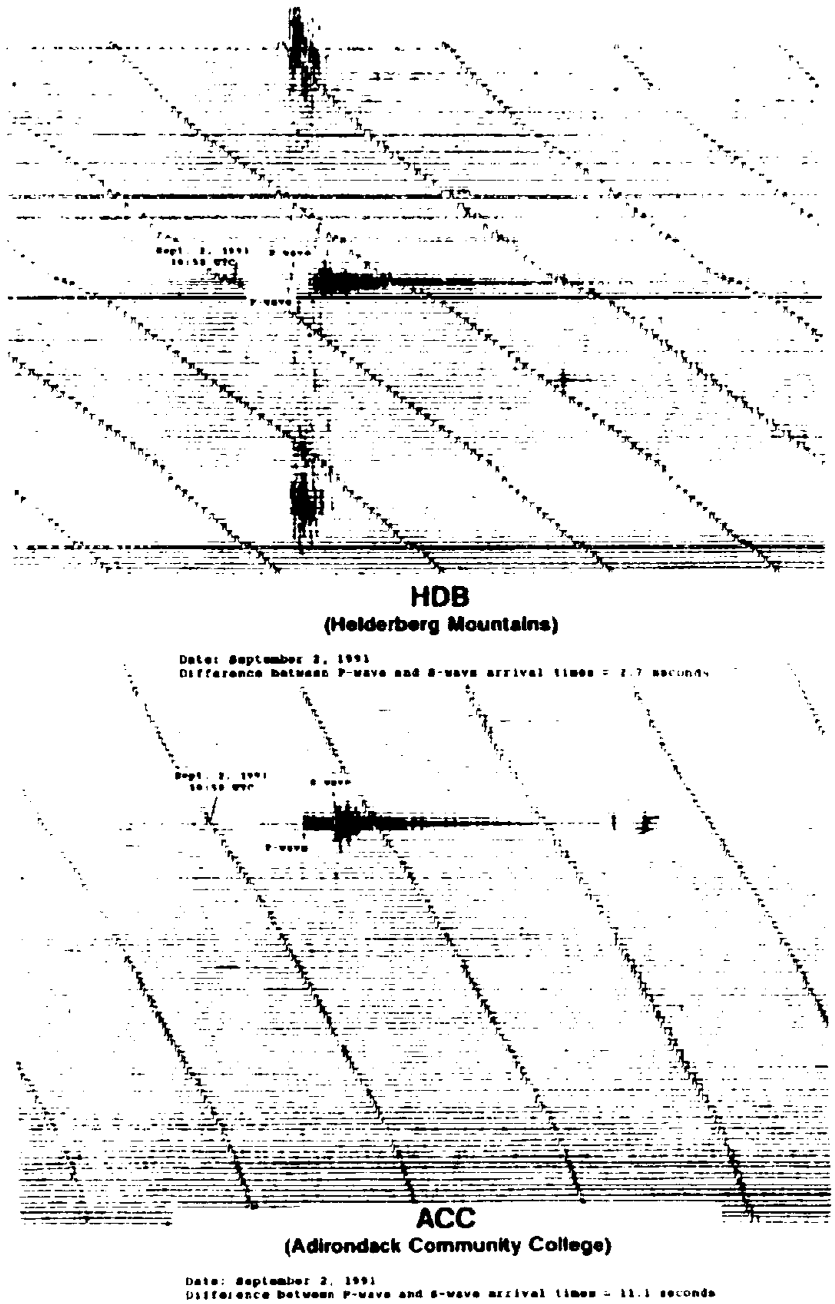

Figure 1: Difference between P-wave and S-wave.

CHT
(Charlton, New York)

Date: September 2, 1991
Difference between P-wave and S-wave arrival times = [illegible] seconds

Figure 1: Difference between P-wave and S-wave (Continued).

Table 1: Earthquake Duration - Magnitude Table for Short-Period Seismographs in the Northeastern United States[1]

Duration (sec)			Duration (sec)		
Equal or Greater Than	Equal or Less Than	Magnitude(M_C)	Equal or Greater Than	Equal or Less Than	Magnitude(M_C)
27	29	1.5	493	546	4.3
30	32	1.6	547	606	4.4
33	36	1.7	607	673	4.5
37	40	1.8	674	746	4.6
41	44	1.9	747	828	4.7
45	49	2.0	829	920	4.8
50	55	2.1	921	1021	4.9
56	61	2.2	1022	1133	5.0
62	68	2.3	1134	1257	5.1
69	75	2.4	1258	1395	5.2
76	83	2.5	1396	1548	5.3
84	92	2.6	1549	1719	5.4
93	103	2.7	1720	1907	5.5
104	114	2.8	1908	2117	5.6
115	127	2.9	2118	2349	5.7
128	141	3.0	2350	2607	5.8
142	156	3.1	2608	2894	5.9
157	173	3.2	2895	3212	6.0
174	192	3.3	3213	3564	6.1
193	213	3.4	3565	3956	6.2
214	237	3.5	3957	4390	6.3
238	263	3.6	4391	4872	6.4
264	292	3.7	4873	5407	6.5
293	324	3.8	5408	6001	6.6
325	360	3.9	6002	6660	6.7
361	399	4.0	6661	7392	6.8
400	443	4.1	7393	8204	6.9
444	492	4.2	8205	9104	7.0

[1] The duration-magnitudes (M_C) were calculated from the formula developed by Chaplin and others (1980). That formula is:

$$M_C = 2.21 * \log_{10}(\text{duration [sec]}) - 1.70$$

Ebel (1982) showed that M_C could be related to true Richter-magnitudes (M_L) in the northeastern United States by the relation:

$$M_L = M_C - 0.4$$

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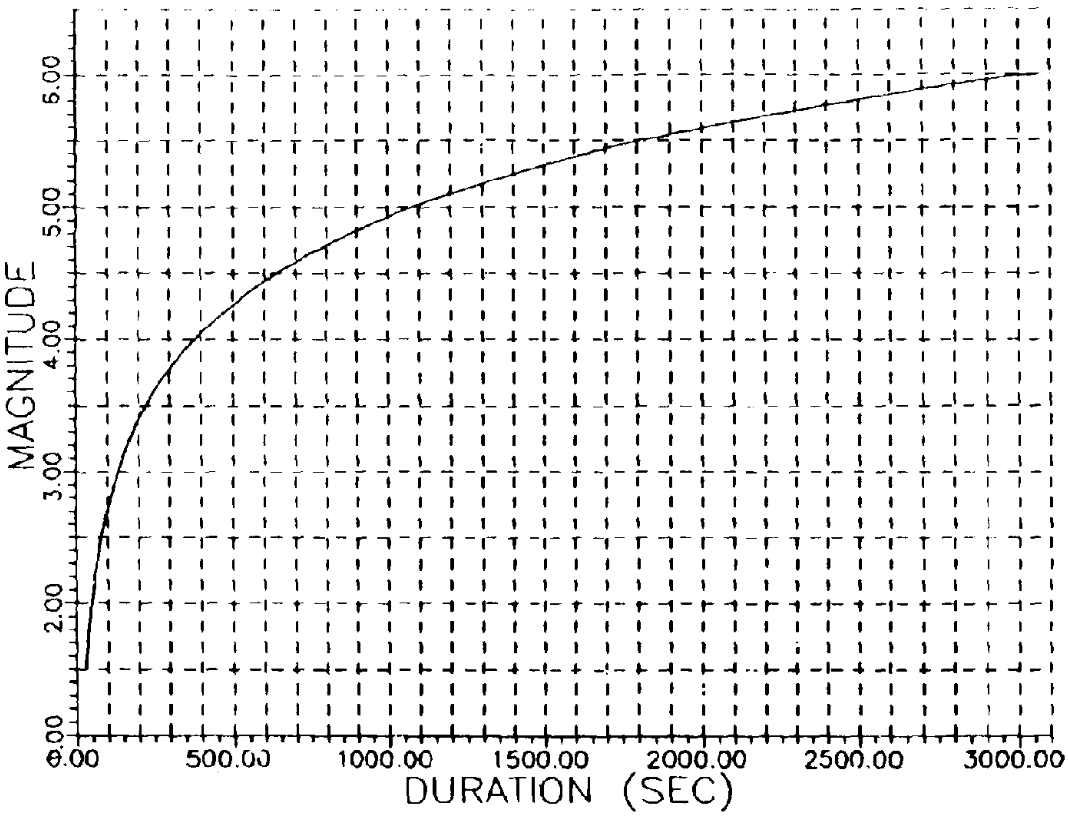
MAGNITUDE
0.00
2.00
3.00
4.00
5.00
6.00
0.00
500.00
1000.00
1500.00
2000.00
2500.00
3000.00
DURATION (SEC)

Part IV

Environment/Structure

Physical Results of Earthquakes and Their Effect on the Built Environment

by Andrea Dargush
Executive Assistant to the Director
National Center for Earthquake Engineering Research

Abstract

An earthquake is a natural phenomenon capable of releasing tremendous energy and altering our natural environment. Dramatic examples include landslides and avalanches, surface ruptures and displacements, liquefaction (the fluid behavior of certain soils under appropriate conditions) and tsunamis, which sometime occur in the aftermath of a coastal or marine earthquake. Furthermore, the earth acts as the transmitting medium for seismic waves originating at the source of the earthquake. These waves may be regionally modified and amplified into potentially-damaging vibrations and undulations in the earth's surface. These physical effects may cause consequent damage or destruction to our built environment. Impact on our built environment may range from severe structural damage nearest the location of the earthquake to architectural damage or damage to building contents many miles away. Our power, water and communication lifelines, as well as our highway infrastructure are also vulnerable to earthquake hazards and disruption to our social and economic systems is a likely post earthquake outcome. Secondary physical hazards which may result include fire and flooding.

In spite of the potential devastation which can result from earthquakes and our current inability to accurately forecast these destructive events, the physical effects of earthquakes are highly predictable. The seismic responses of our manmade and natural surroundings are rooted in fundamental concepts of physical science. A basic understanding of the science principles at work during earthquakes may allay fear and ignorance which often accompanies natural disasters and can promote a better understanding of pre-earthquake planning and preparation activities. This paper will review some of these fundamental concepts and describe potential physical effects of earthquakes on our environment.

Effective earthquake education can empower a school population to mitigate potential dangers of earthquakes.

Introduction: Earthquake Myths and Realities

People have speculated on the causes of earthquakes for thousand of years -dating back as far as 600 BC. These speculations have led to various myths and legends. A popular Japanese belief centered around the idea that the earth rested on the back of a catfish-which rocked the earth when provoked. Renaissance Europe came to view earthquakes as acts of an angry god seeking retribution for the sins of the people. There are even myths and legends associated with earthquakes that have occurred in New England. One such example concerns noises which have been heard near East Haddam, Connecticut.

The Moodus noises are mysterious sounds - like rifle shots, cannon fire or distant thunder that have long been heard in the vicinity of East Haddam, Connecticut; often in the company of earthquakes. It is said in fact that the word Moodus actually comes from the Native American words for East Haddam which means "noisy place". The natives thought the noises were made by an angry god, who upon seeing the Englishman's god in his territory, growled a warning. The English, on the other hand, suspected that the noises resulted from satanic rituals they believed were performed by the Native Americans.

Today's base of scientific knowledge teaches that earthquakes are natural phenomena which result from the movement of large rigid portions of the earth's crust and the subsequent rupture of rocks in the subsurface. In looking at a map of earthquake occurrences (Figure 1), one notes that there are concentrations of earthquakes in certain areas. These locations coincide with breaks in the crust and define the boundaries of the earth's plates, where most earthquakes occur. Strain builds at junctures between plates as they make contact with each other and energy may be dramatically released by earthquakes or volcanoes. A notable crustal boundary between the Pacific and North American plates occurs along the western coast of North America. The seismically active San Andreas fault is a result of this break between the plates. As seen in Figure 1, earthquakes have occurred not only in California, but across the entire US.

Indeed, even the Northeast US has had its share of earthquakes. Earthquakes in these regions are also related to plate tectonics and most likely result from the build-up of strains from pressures developed at plate boundaries.

So what are the specific circumstances which occur at these locations that lead to earthquakes? Layers of rock in the earth's subsurface are subjected to various forces (in most cases, tectonic forces) which compress, stretch and twist the rock to a point at which it is no longer elastic and rupture occurs. The fracturing begins at a point called the hypocenter or focus and extends over a rupture plane or fault. The epicenter of an earthquake is the point at the surface of the earth directly over the focus which serves as its geographic point of reference.

As the fracturing occurs, energy is released. While most of the energy is dissipated by the breaking and fracturing of rock, part of the energy is radiated outward in all directions from the focus and rupture plane in the form of seismic waves. There are two principal types of seismic waves: body waves (P and S) and surface waves (Rayleigh and Love). Body waves travel within the body of the earth and are generated directly by the fracturing rocks. P waves cause compressional stresses in materials and arrive first at the surface, providing the initial jolt; S waves generate shear stresses and arrive slightly later with typically a sharper jolt. Surface waves travel over the land surface at slower speeds and are often the primary cause of damaging ground motion. Because of the different properties of the waves and the heterogeneous nature of the earth's layers, these waves bend and reflect as they travel, arriving at the surface from different directions and at different times. As a result, the ground motion we feel is a composite effect of several kinds of waves.

Seismographs are used to measure ground motion during earthquakes. The amplitude of the seismic waves recorded by seismologists is used to determine the magnitude of the earthquake. While there are many different ways to express magnitude, the most familiar is Richter magnitude, which is closely related to the energy released in an earthquake.

While magnitude is an objective quantifier of an earthquake's size, the Modified Mercalli Intensity scale is often used as a subjective indicator of what degree of shaking is felt or observed at different locations after an earthquake. Because the ground motion may vary from place to place during an earthquake, there may be several observed intensities ranging from high intensity near the epicenter and lower intensities at distance. Only one magnitude value will exist for an earthquake. Magnitudes are essential to scientists and engineers to predict strong ground motion and to effectively design seismically-resistant buildings. The descriptive Mercalli scale continues to be important, however, because there are many seismic regions which are not seismographically monitored and because the long historical record of earthquakes which occurred preceding the advent of seismograph is based on such descriptions.

EARTHQUAKES OCCUR THROUGHOUT THE UNITED STATES.

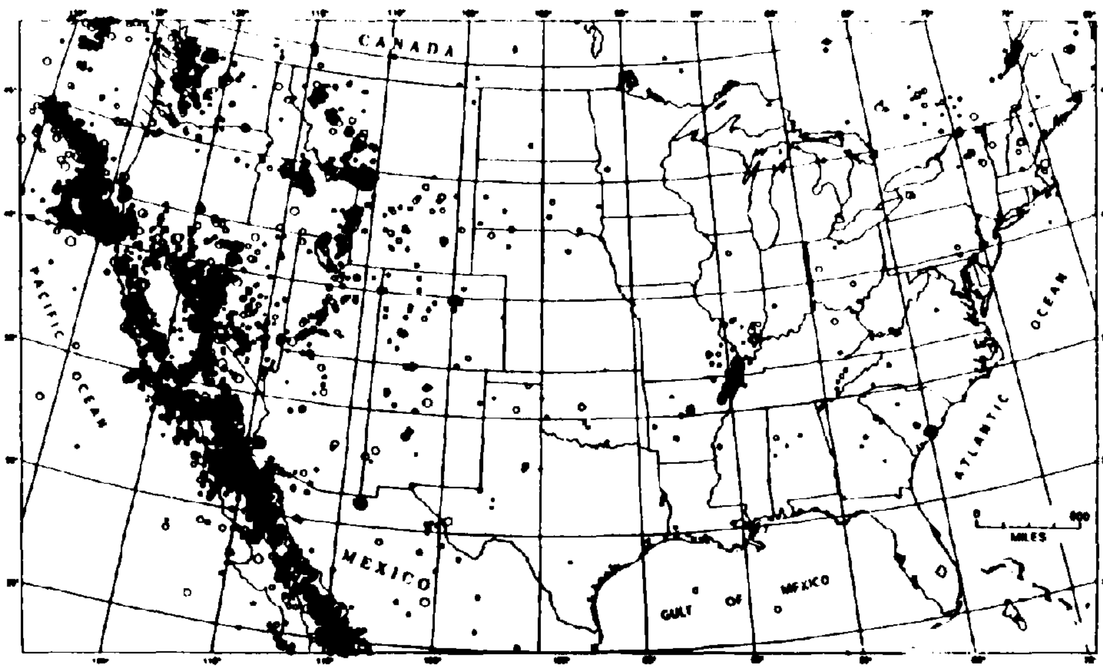

Figure 1: Earthquakes occur throughout the United States.

Impacts on Our Natural Environment

Impacts on our natural environment can be observed in our natural and manmade environment after earthquakes. As shown in Table 1, the natural hazards fall into four categories: the first is surface rupture - a visible crack or offset in the ground surface. In some cases, fault movement causes horizontal displacement as seen along the San Andreas. Vertical displacement is also possible. Primary surface displacements occur only along the fault line where the earthquake originated and should not be confused with cracks that appear away from the fault in roadways or fields which open as a result of landslides or slumps. Surface rupture poses the greatest threat to structures built in a fault zone. Even the most flexible or well-designed building cannot withstand the displacements generated by a moderate to large earthquake without sustaining significant damage.

Seismic design improvements do not provide a practical solution to damage caused by surface rupture; better approaches would be to enact zoning laws to regulate construction in fault zones and to require site studies. The Alquist-Priolo Special Studies Zone Act is an example of a regulation in effect in California to prevent some types of residential construction in active fault zones. These approaches are essential in the case of critical structures (dams, power plants), emergency facilities (hospitals, police stations), and other important structures such as schools and public buildings. In this regard, the Eastern and Central US are at a distinct disadvantage. Although we know that earthquakes have occurred in these areas, it is difficult to identify the location of the seismogenic faults. There are two reasons for this: first, earthquakes recur so infrequently in the East it is difficult to collect definitive data to identify active faults, and secondly, because earthquakes in the East typically do not rupture at the surface as they commonly do in California. Furthermore, because faults are not readily observed at the surface, we cannot easily predict where a new earthquake might occur.

The second category of physical effect is ground motion. If the earthquake is large enough, seismic waves can create enough ground motion to cause vibration in structures and sometimes damage or collapse, even many miles from the epicenter. Because of the interaction of the different types of seismic waves causing the motion, the actual ground movement will be random, predominantly horizontal and sometimes with a considerable vertical component. Normal building design for vertical forces (the weight of the building and its contents) incorporate such large factors of safety that additional vertical forces generated by earthquakes are unlikely to be a problem. For that reason seismic design concentrates more on minimizing the effects of horizontal forces.

Because seismic waves are affected by soil conditions and topography, ground shaking during an earthquake may be more intense in some areas than others. The October 1989 Loma Prieta (California) earthquake provided some interesting lessons on the differences in ground shaking within a region. Earthquake acceleration is the rate of increase in ground velocity as seismic waves travel through the earth. Extremely high accelerations of the ground motion generated by the earthquake's main shock in certain areas was too great for some structures. Accelerations measuring 10% of the force of gravity are usually sufficient to produce some damage to weak construction. An earthquake-caused acceleration that nears 50% g on the ground is very high. Data collected during the Loma Prieta earthquake indicate peak accelerations over 60% g. Soil conditions contributed to these accelerations. Harder soils and bedrock transmit short period vibrations. Softer soils transmit larger period vibrations from distant sources. Forces on a building will increase when the period of the ground vibrations approaches the natural period of the structure. In general, taller structures have longer periods than shorter buildings. Frequency, duration of the ground shaking and quality of building construction are also important considerations. But proper design strategies can help minimize these effects.

The third category of physical effect is ground failure which includes landslides - mass movement of the earth along a slip plane, differential settlement, and liquefaction - the fluid-like behavior of certain soils under particular earthquake conditions. Sand boils are surficial deposits of sands which have been ejected from a confined, overpressured subsurface layer.

Table 1: Physical Effects of Earthquakes
Consequences to our natural environment: • Ground surface rupture and displacement along a fault • Ground shaking • Ground failure: - Landslides, mudslides - Soil liquefaction - Differential ground settlement - Avalanches • Water hazards: - Tsunamis - Seiches - Floods resulting from dam failures
Consequences to our man-made environment: • Damage to (or collapse of) buildings, bridges and other structures • Disruption of transportation, communication, power and water supply and sewer systems • Falling and overturning of objects inside and outside of buildings • Fires from tank failures and gas pipeline breaks • Dam failures • Chemical and radioactive leaks

Structures built on these liquefiable foundations may experience increased vibration or undermined foundations as seen in Figure 3, because the soil can no longer bear the weight of the structures or soils above it.

The major damage to homes in the Marina District of San Francisco after the 1989 earthquake was caused by locally amplified shaking and ground deformation as a result of liquefaction. Buildings in the district were constructed on sand and debris which were used to fill the former lagoon for the 1915 Panama-Pacific International Exposition.

The fourth category of natural hazard relates to earthquake induced water hazards which may take place on the open sea or in a closed body of water. Seismic sea waves or tsunamis may cause a great deal of damage from flooding, wave impact, debris impact and coastal erosion. In the tsunami generated by the 1964 Anchorage, Alaska earthquake, boats and their moorings were stripped from the shore and carried inland. The same earthquake-generated sea waves that battered boats in San Francisco Bay marinas, also hit Cresent City, California, destroying several hundred buildings and killing 11 people. Ninety-eight people were killed in Alaska, where there was inadequate time for a warning to be issued.

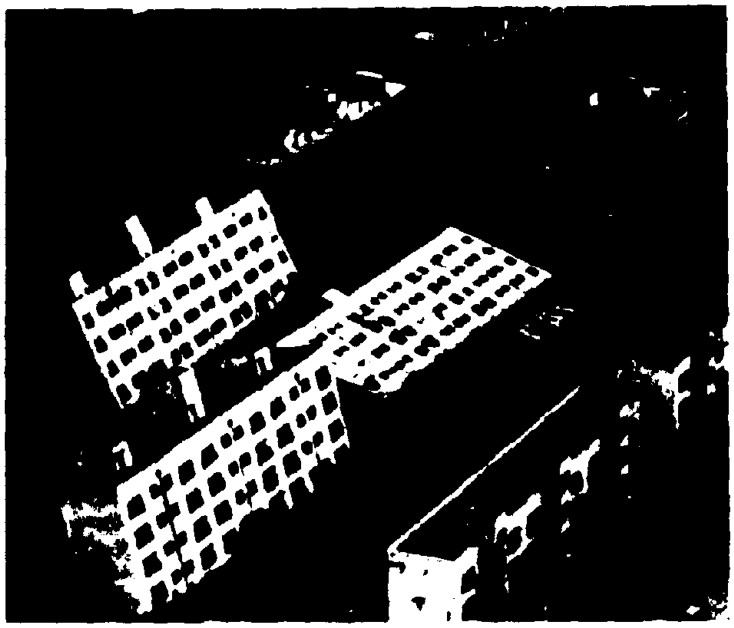

Figure 3: Liquefaction of the underlying soil resulted in the tilting and settlement of these Japanese apartment buildings after the 1964 Niigata earthquake.

Impacts On Our Man-made Environment

In looking at the natural hazards which can result from earthquakes, it is apparent that it is somewhat difficult to consider these effects independently. It is human nature to relate these changes in the earth to the impact they have on our community. The effects of earthquakes include both the natural hazards which earthquakes present and the changes which they effect in our building and bridges and our socioeconomic systems. We need to consider the types of natural hazards likely to occur, their frequency, spatial extent, physical characteristics and adverse consequences to project what potential losses to life and property might result from these natural events so that we may take appropriate actions toward preparedness and mitigation.

Some specific examples of earthquake impact on the built environment include damage to buildings. Buildings are in general designed to accommodate the loads which typically act on the structure - including the weight of the structure, its occupants and contents, and the force which might be exerted by wind or snow. Earthquake loads are different, however, since ground motion at a site is a composite of seismic wave motion and is somewhat random. They affect structures dynamically - changing rapidly during the earthquake - and the characteristics of the motion may vary greatly from one earthquake to another.

Earthquake ground motion causes the mass of a building to vibrate, generating potentially large inertial forces in relation to the size and shape of the building. The horizontal forces of ground motion bend, shear and twist the columns, beams, floors and walls of the buildings, eventually deforming and weakening the structure until it collapses due to the force of gravity.

Certain general elements make buildings more resistant to earthquakes. Structures which exhibit symmetry and regularity in shape perform better and are less likely to experience twisting or torsion during an earthquake. Structural continuity is also important. Features such as columns or shear walls should continue through the entire structure to avoid concentrations of stresses at the points where the strength or stiffness of the building changes.

It is also important for structures to exhibit ductility. Certain building materials contribute more effectively to a structure's ability to bend and sway with earthquake motion. Materials such as adobe, brick and concrete block are brittle and typically perform poorly during earthquakes. Wood frame houses, when adequately tied to their foundations, possess greater ductility, and steel frame buildings are notably more ductile during earthquakes.

Other engineering approaches which improve a structure's seismic performance include the application of resisting systems to minimize lateral forces, strengthening of connection points of the beams, columns, walls and slabs so that buildings function as a unit, and reinforcing the building materials. New engineering technologies are also being developed which allow vibration reduction in a structure through the application of devices to absorb shock, to actively counteract earthquake forces or to effectively decouple a structure from its foundation during earthquakes. Figure 4 depicts a building which has been seismically strengthened by a combination of these approaches.

Bridges are also vulnerable to earthquake motions, particularly those caused by long-period surface waves. Bridges are part of those support systems-or lifelines-whose functioning is vital to an area after experiencing an earthquake. Other lifeline systems are electrical generating and distribution systems; water and sanitary systems; fire, rescue and medical facilities; and transportation networks and communication systems. A notable example of bridge damage would be the collapse of the Cypress Street viaduct of the I-880 Freeway in Oakland, California as a result of the October 17, 1989 earthquake. The collapse, which was responsible for 41 deaths and numerous injuries, was attributed to the design and construction of the joints between the lower deck and upper deck columns, inadequate reinforcement for shear forces in columns and possibly to amplified ground shaking caused by local ground conditions. Plans to strengthen the viaduct prior to the earthquake had not been carried out due to lack of funds.

In addition to loss of life and elimination of vital access routes, it is estimated that the cost of the earthquake to the transportation system was $1.8 billion.

Earthquakes can also cause damage to other lifelines. Ruptures in gas lines may result in fires; breaks in the water supply system may significantly impair ability to control the fires. The city of San Francisco was devastated by an earthquake in 1906. It has been difficult to assess the degree of destruction which occurred during ground shaking as a result of numerous fires which broke out, destroying the predominantly wood building stock. The city's ability to combat the fires was severely impeded due to damage of the water supply systems. The fire, which burned for three days, is estimated to have produced perhaps 10 times more damage than did the ground shaking.

Earthquakes also pose a threat to emergency facilities, critical structures and dams. Because it is essential to prevent or minimize damage to these structures, they benefit from the application of more stringent design standards, advanced engineering methods and better construction techniques.

A more common but equally dangerous hazard which can occur even in moderate earthquakes is damage to or collapse of chimneys. After the Loma Prieta earthquake, approximately 80% of the chimneys in Santa Cruz County sustained some damage.

Moderate earthquakes can cause additional architectural and nonstructural damage, such as cracked and fallen plaster, fallen light fixtures, overturned waterheaters and bookshelves and disrupted building contents. Overturned furniture, appliances and equipment, the displacement of articles from shelves, cabinets and closets and broken objects, become dangers as well as obstacles to quick recovery.

Educational facilities pose a unique seismic design problem; while constructed similarly to other buildings, their size, occupancy and purpose differ. School buildings have the highest occupancy density of any building type, making emergency evacuations potentially difficult. The buildings themselves are complex, combining small classroom and office spaces with both large assembly areas and laboratories. Damage to schools during earthquakes may prohibit their use as needed public shelters and add to a community's social and economic burdens after an earthquake. Even damage to school equipment and contents alone can approach almost half the worth of the facility.

The 1933 Long Beach, California earthquake (magnitude 6.3) heavily damaged 75% of the public school buildings. Fortunately its occurrence in early evening allowed the city to avoid a horrible tragedy. Within one month the Legislature of the State of California approved the Field Act to provide protection of life and property by setting design and construction standards for elementary and secondary schools and community colleges.

The effectiveness of the Field Act has been tested in subsequent years. One test occurred during the 1952 Kern County earthquakes, one magnitude 7.7, one magnitude 5.8. Of the 37 schools suffering damage, schools designed in accordance with the Field Act sustained less than 1% damage loss, while pre-Field Act schools sustained more than 50% damage loss.

These are graphic examples of the need to retrofit and construct seismically sturdy school buildings. But there are other considerations as well; our moral and legal responsibility to protect children, the provision of emergency shelter, the need to replace aging facilities.

It is estimated that by the year 2000, 50% of existing school buildings will be between 40 and 80 years old. It is of primary importance that seismic design considerations be made in the construction of these new facilities.

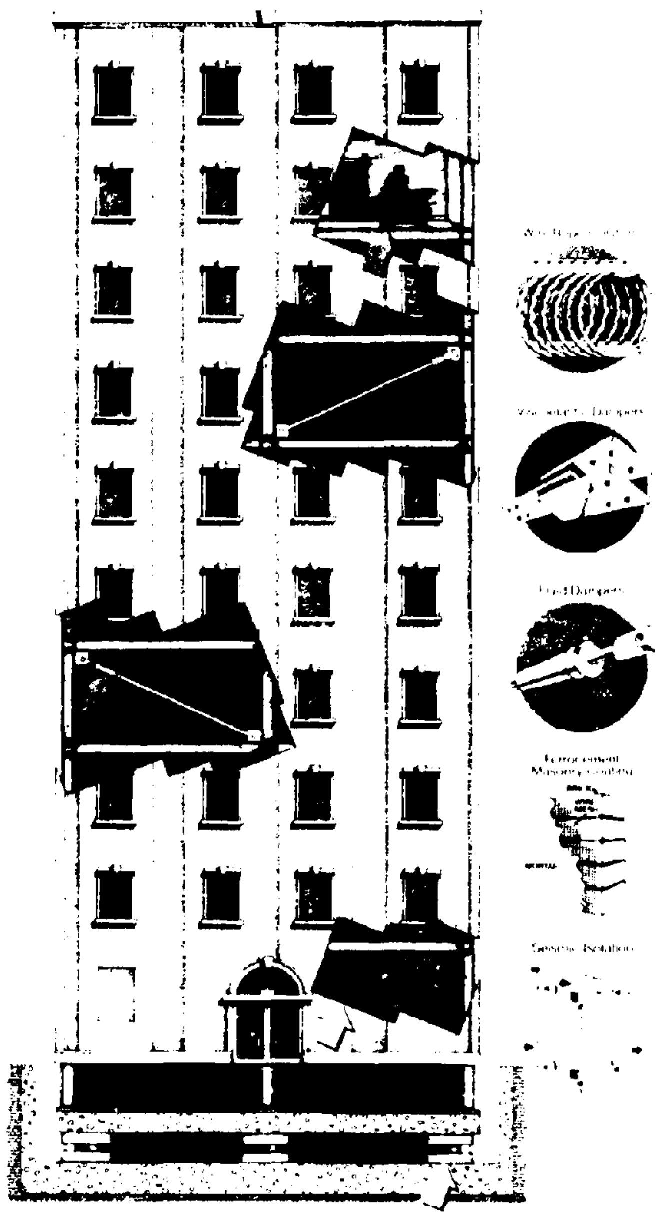

Figure 4: Examples of devices to improve the seismic resistance of buildings.

Implications

In the aftermath of a severe earthquake, it is l...ely that our socioeconomic systems will suffer. A community's ability to provide emergency aid may be hampered by damage to buildings and infrastructure, alternative housing and sheltering may be needed, communication and power may be disrupted, commercial and financial institutions may be unable to function. All of these are barriers to a community's return to normal operation and place stresses not only on its economic health but on its necessary social systems.

Strengthening and protecting our built environment from the impacts of earthquakes can minimize these losses and disruptions to our communities. In reality, however, complete earthquake protection is unlikely because society is reluctant to pay the costs and is willing, to an extent, to accept the risk that a great and devastating earthquake may never occur.

We became all too familiar with the devastation which can be caused by a natural disaster, as evidenced by the impact of Hurricane Andrew and South Florida's painful recovery. A fundamental difference between hurricanes and earthquakes, however, lies in the fact that hurricanes can be forecast! In spite of our technological advancements, accurate and timely earthquake prediction is still an achievement to be realized. It is important for our society to understand the consequences of natural disasters, the level of risk involved, and to know and appreciate the actions which can be taken to safeguard their lives and property.

This understanding can be significantly advanced in elementary and secondary school students by effective instruction of fundamental science concepts which relate earthquakes to society as well as to other natural, manmade and technological hazards. Accurate instruction of scientific concepts provides a foundation for the development of rational thought processes, leading students to a better appreciation of the causes, effects and appropriate mitigation activities related to earthquakes.

The development of a future generation of scientifically literate adults can benefit society through the enhanced ability of the public to make logical and defensible decisions on issues and policies relating to earthquake mitigation as well as other scientific and technological issues; from adoption of seismic requirements and zoning laws, to support of Federal spending for research.

This type of increased awareness and education is invaluable to the success of our society's efforts to minimize its earthquake risk.

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The Massena Center, New York, Earthquake of 1944 and its Effect on Area Schools

by Gary N. Nottis
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Walter Mitronovas
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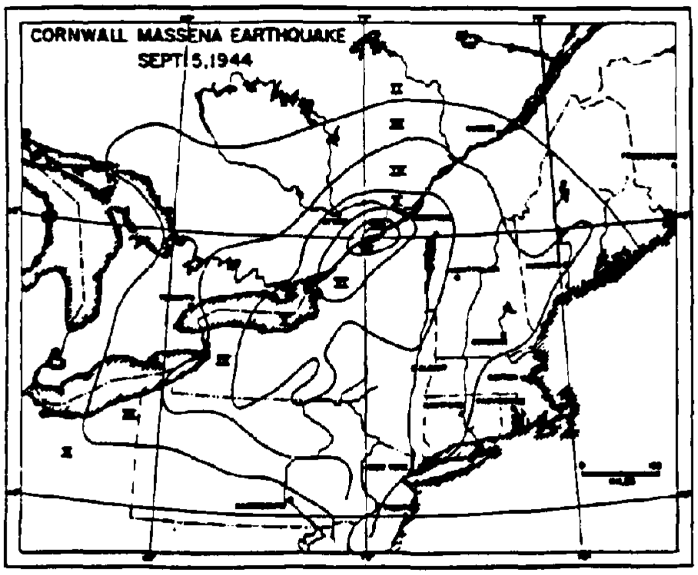
Abstract

The greatest threat to people in schools during a damaging earthquake will probably come from non-structural damage and the movement of building contents. An earthquake of magnitude 6.0 occurred at 04:38 UTC (12:58 A.M. local time) on September 5, 1944, near Massena Center, New York. To date, it is the largest earthquake to have taken place in the northeastern United States since the 1755 Cape Ann, Massachusetts, event, although larger events have occurred in adjacent Canada. The 1944 event caused significant damage to schools in Massena, New York, and Cornwall, Ontario. Opening sessions for Massena's public schools were postponed for one day so the buildings could be inspected for structural damage. No major structural damage was found. However, non-structural damage such as fallen plaster and broken windows were reported for nearly all of the public school buildings in Massena. Most of the plaster probably contained asbestos which has been regulated as a potential health hazard since 1972. About 150 windows were broken at Massena High School. At Washington School, the chimney was damaged; many windows were broken; blackboards popped off walls; and much plaster fell. Fallen plaster was the only damage reported at Massena's parochial schools, which were smaller buildings, and they were not closed for inspections. Throughout Massena, it was commonly reported that plumbing was damaged, books were thrown from shelves, wall-mounted objects fell, and bottles of liquids were broken after being thrown from shelves and cupboards. Similar movements of building contents presumably occurred in the schools as well, but were not reported in the press. Schools in Cornwall apparently suffered the same kinds of damage and content movements as those in Massena. In addition, a large section of brick coping on the new Cornwall High School fell three stories and destroyed the timber roof of the gymnasium. The school damage and content movement during this 1944 earthquake were similar to those seen during the 1983 Coalinga, California, e - ,uake. We believe that an earthquake as large as the 1944 event can occur anywhere in the northeastern United States at any time. It is possible that even larger earthquakes can also occur within the northeast similar to those that have occurred in adjacent Canada. Schools in the northeastern United States need to include the threat of earthquakes as part of their emergency plans. Figure 1 shows regions of equal seismic intensity as felt throughout New York and the surrounding areas as a result of this earthquake.



Map at left shows regions of equal seismic intensity as felt throughout New York and the surrounding northeast as a result of the 1944 Cornwall-Massena earthquake. From "Guidelines for Assessing the Nature and Extent of Earthquake Hazards in the New York Area and Devising Options for Research and Mitigation", Walter Hays, USGS Open File Report 85-386; December, 1984, pp. 29-42.

Figure 1: Massena earthquake.

Figure 2: Currently, the only surviving photo of the 1944 earthquake damage is one of this chimney at the Nicola residence, 129 North Main Street. Over 90% of the chimneys in Massena were damaged or destroyed.

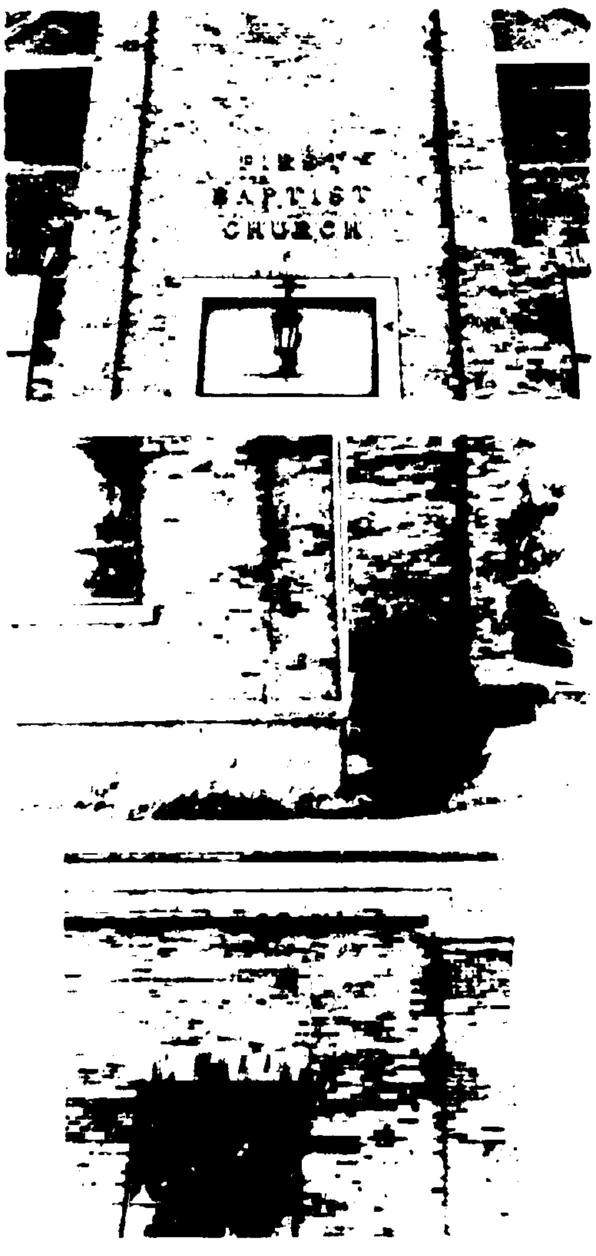


Figure 3: Baptist Church, Massena. Each photo shows where large cracks in unreinforced masonry caused by the 1944 earthquake were repaired.

Recorder Notes
Environment/Structure

by Andrea Dargush, Discussion Facilitator
National Center for Earthquake Engineering Research

Alan Goldstein, Recorder
New Jersey Earth Science Teachers Association

How can individuals take an active role in non-structural hazard mitigation in the schools?

1. Assessment of individual classrooms and entire school by groups of students
    Multiple teams are a good idea
        Competition between teams keeps them "on their toes"
        Teams spread the word to others

2. Make others aware
    Laboratory teachers, custodians, etc.

3. Identify hazards and inform local police, fire chiefs, insurance agent, etc.

4. Take FEMA's EMI (Emergency Management Institute)
    TTT (Train-the-Trainer) course at Emmitsburg, MD to become a trainer yourself

How can individuals take a more pro-active role in the enactment of seismic building codes?

1. Find out about the current code to determine if it has a seismic provision

2. If the code does not have the seismic provision, an update will be required to comply with Executive Order #12699. This order requires all new buildings utilizing federal money, assistance or involvement to incorporate seismic provisions.

Should the state mandate seismic provisions in building codes? Should it be just for critical facilities? All facilities?

1. It is necessary to separate existing structures from new construction
    New construction must comply with Executive Order #12699
    Retrofitting is more complex, both politically and economically

2. Massachusetts has a seismic advisory committee
    Other states probably do also
    We could get involved

What liability does/or should the school have if seismic hazard mitigation is not implemented and a damaging earthquake does occur?

1. New buildings - liability will be great as a result of Executive Order #12699

2. Existing buildings - liability is uncertain
   Considerations

   How likely is that there will be an earthquake?
   How likely is it that an earthquake will produce litigation?
   Is not knowing about something enough to keep a school district from being liable?
   How likely is it that litigation will find the school district liable?
   How socially responsible are the people in charge?
   How politically and economically acceptable will it be to spend money on retrofitting?

How much regulation should be enforced for existing structures?

1. Regulations often require that the majority of financing come from the regulated
   An overall retrofit may be out of reach
   A phase-in might be a more reasonable option
   Ex: Requirement that securing of parapets be attended to at the time a roof is repaired, etc.

How do we get those in power to change things?

1. Awareness of liability
   Liability is usually recognized only after a disaster

2. Education of those in power to make decisions.
   Make a presentation.
   Convince individuals to do the easy things first (such as taking care of non-structural hazards)

3. Legislation - such as E. O. #12699 requiring compliance

Part V

Emergency Preparedness - More Than "Duck, Cover, Hold"

Earthquake Preparedness: A High School Perspective

by Virginia Kimball
Earthquake Safety Consultant

Abstract

Topics related to earthquake safety and ways to discuss earthquake safety with high school students will be the focus of this presentation. Students can be helped by the discussion leader's attitude of confidence and understanding of the school plan and the reasons behind it. It will be recommended that the following messages be reinforced during discussions:

1. Earthquakes are powerful events, and **it's normal to be scared or anxious during and after a quake.**

2. **The school has a plan.**

   a. Duck, cover, and hold during the quake. As students get bigger, desks seem to get smaller, but there are safe ways to brace under all types of school desks. People are protected by the rows of desks as well as each individual desk or chair.
   b. Afterwards, check and protect yourself. Check others for injuries and assist those who are injured.
   c. Look around the classroom to assess the entire situation: is there damage, smoke, or any other hazardous condition that might require an immediate evacuation? If not, each teacher will check with his or her buddy teacher, assisting that class if necessary, and wait until composure has been reached before carefully evacuating to the assembly area.
   d. The duck, cover, and hold procedure will be repeated for each aftershock, followed by another situation assessment.

3. **Students should remain at school until a parent or other previously designated adult arrives to pick them up.** This is the rule for all emergency situations where the environment outside the school may not be safe.

Discussion Guide for "Earthquake Preparedness: A High School Perspective"

"Earthquake Preparedness: A High School Perspective" was produced by the Pasadena Unified School District for middle and high school students to be used as a stimulus for discussion about earthquake safety. After viewing the video, we suggest that the topic to be discussed in an open and supportive atmosphere. The target audience is high school students, however, middle school students may be able to absorb the key messages, too. It might be helpful to show the 11-minute video, "A Time to Prepare: The PUSD Earthquake Plan,"[10] to middle school students first, in order to give them a clear picture of the plan.

As a discussion leader, you can help students by your attitude of confidence and understanding of the school plan and the reasons behind it. These are the messages we intended to deliver in the video, and you can reinforce these during your discussion.

[10] More information about this 10 minute, 50 second video tape can be obtained from the author.

Part V - Emergency Preparedness - More Than "Duck, Cover, Hold"

1. Earthquakes are powerful events, and **it's normal to be scared or anxious during and after a quake.** This would be an appropriate time to discuss individual experiences.

2. **The school has a plan.**

   a. Duck, cover, and hold during the quake. As students get bigger, desks seem to get smaller, but there are safe ways to brace under all types of school desks. People are protected by the rows of desks as well as each individual desk or chair.

   b. Afterwards, check and protect yourself. Check others for injuries and assist those who are injured.

   c. Look around the classroom to assess the entire situation: is there damage, smoke, or any other hazardous condition that might require an immediate evacuation? If not, each teacher will check with his or her buddy teacher, assisting that class if necessary, and wait until composure has been reached before carefully evacuating to the assembly area.

   d. The duck, cover, and hold procedure will be repeated for each aftershock, followed by another situation assessment.

3. **Students should remain at school until a parent or other previously designated adult arrives to pick them up.** This is the rule for all emergency situations where the environment outside the school may not be safe.

Note: a few high school students have trouble with the above policy, probably because they don't really understand the reasons for it. We're giving you the following reasons so you will have the necessary background:

After an earthquake, there may be blocked streets, fallen electrical lines, burning fires, clouds of hazardous chemicals, damaged buildings, and more earthquakes (aftershocks).

Because of traffic jams, signals not working, cracked streets, fallen bridges, and debris, it is not likely that people will be able to travel more than a short distance in cars following a big earthquake.

If students leave school on their own, either on foot or in cars, they may be injured by falling debris, explosions, and other hazards, and no one will know where they are or how to help.

Students who arrive home alone may find very dangerous conditions, such as leaking gas that might explode when the door is opened, or broken glass that will fall during aftershocks. Their family members may not arrive for hours or days.

Parents who work more than a few miles from their home may not be able to get to the schools to pick up their kids for several hours, overnight, or even longer. Many people may be trapped at work - safe, but not able to leave because of blocked roads and other problems. Some parents may be injured and unable to leave.

Since schools are prepared to take care of students for as long as necessary, and since schools are required to be structurally stronger than other buildings, schools are the best place for students to wait and for families to reunite. The students will be with their friends, and can support one-another. The teachers and their staff will stay to take care of students as long as it takes.

Coordinating Earthquake Preparedness Efforts with the State Education Department: An Example from Arkansas

by Dan Cicirello
Earthquake Preparedness Supervisor
State of Arkansas

Abstract

There have been three glaring facts that have motivated me for the past eight years to seek out support of earthquake preparedness and education in the schools of Arkansas.

The first, of course, is without earthquake preparedness and education in our schools that very precious part of our population is at constant risk to unnecessary death or injury. Next, I have been fully aware that the earthquake preparedness of tomorrow lies in the hands of the children of today! And third, those successes in the earthquake preparedness program we experience today must be sustained tomorrow by today's children.

I propose that regardless of the organizational structure of a state's education system, support can be successfully garnered to implement earthquake preparedness and education in schools.

The secret is to motivate the parents who in turn motivate local school officials to include such programs in their schools.

The Importance of Parents

Parents can be great allies. Once they have become convinced their children are at risk without earthquake education programs, they will then convey that information to school board members, school superintendents, principals and teachers. I say this with confidence due to my experience in Arkansas. From 1985 through 1989, my office provided approximately 618 graphic earthquake lectures to about 27,077 members of local and state service organizations (i.e. Lions, Rotary, Kiwanis, Professional Women's Association, etc). We also distributed 184,991 earthquake preparedness/education pamphlets and booklets to the public during this same period of time. As a result, requests from local school officials for lectures to their faculty, staff and students began and gradually increased.

Two state representatives, Charles Moore and Owen Miller, in 1987 introduced and passed the joint resolution "that the school boards of the school districts located (in the 24 counties at earthquake risk) are urged to design school buildings - in accordance with standards that will be earthquake resistant..."

Further School Efforts

During 1986, my office developed a talking teddy bear, "Ready Teddy," to talk to K-4 grade school children about basic earthquake safety responses. This effort caused more requests from local schools and lectures for fifth and sixth graders, and 7-12th graders were added.

Local school official interest increased. When FEMA, through the guidance of Marilyn MacCabe, produced the "School Earthquake Program Guidebook," our office provided enhanced copies at multi-county workshops to the personnel of 285 public and private schools. During 1988, those same schools received copies of Earthquakes: A Teacher's Package for K-6. This curriculum was developed under the leadership of Marilyn MacCabe by the National Science Teachers Association[11].

Coordinating Efforts with the State Education Department

In March 1989, immediately after the passage of Arkansas Act 247, "An Act to Establish an Earthquake Preparedness Program," which "requires the full cooperation of all other state and local government agencies...", I contacted Dr. John Gill, curriculum director of the Arkansas Department of Education. At that time I requested a regulatory memo for earthquake preparedness and education in the schools. Dr. Gill confided in me, some time later, that after I made this request he immediately contacted the directors of the educational cooperatives to see how they felt. There was overwhelming support for such a memo! He noted that such a positive response for additional regulation surprised him. Upon inquiry, he was informed that the support of the emergency management office to local schools made them aware of the need for such regulation. Parents expected it.

The Arkansas Department of Education was also very supportive of the NCEER-sponsored workshop, *Earthquakes in Arkansas: The Potential for a Generation Lost?*, held June 12-13, 1990. The department director sent letters to all school districts, encouraging attendance by the school superintendents and principals.

Last year, the Emergency Management Office was approached by the Department of Education to train 605 junior fire marshals from 56 school districts to recognize nonstructural earthquake hazards and report such conditions when they are found, to their principals. This year, a Governor's Task Force on School Safety has charged the Department of Education to provide specific guidance for earthquake preparedness, earthquake hazard identification and reduction, and earthquake drills. The Department of Education has, in turn, requested our assistance with accomplishing that task during FY '93.

Conclusion

At the present time, Arkansas has a successful earthquake preparedness program coordinated between education agencies in the state. For those states that do not have strong state education department influence over local schools, realize that the procedure used to get local school support in Arkansas can also be used in your state - by motivating the parents. An example of such an effort comes from the "Pennies for Safety" project developed by Terry Gabrielson, a principal of the Blytheville School District. Mr. Gabrielson developed this program without direction from the State Department of Education. Through this program, Blytheville Elementary Schools raised $10,000 in 20 days which was used to buy 350 earthquake preparedness safety kits.

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[11] This curriculum is available from FEMA - Earthquake Education (625), Washington, DC 20472. Send single copy requests on school letterhead for a free copy, while supplies last. It can also be purchased from NSTA (202) 328-5800.

Arkansas
DEPARTMENT OF EDUCATION
4 STATE CAPITOL MALL · LITTLE ROCK, ARKANSAS 72201-1071 · (501) 682-4475
RUTH S. STEELE, Director, General Education Division

Director's Memo No. 89-18
May 26, 1989

REGULATORY

TO: Superintendents, ESC Directors, and Persons Interested in Earthquake Preparedness Programs

FROM: Ruth S. Steele, Director, General Education Division
Emma Bass, Associate Director, Instructional Services

SUBJECT: "The Arkansas Earthquake Preparedness Act of 1989"

Act 247 of 1989, effective February 24, 1989, charges the Office of Emergency Services, Earthquake Preparedness Program, with the responsibility of carrying out such programs and requires the full cooperation of state agencies, offices and personnel to the end that the most effective earthquake mitigation, preparation, response and recovery capabilities may be accomplished.

Twenty-four counties in Arkansas (from Randolph in the northeast to Chicot in the southeast, and affecting approximately 650,000 citizens) are on or in close proximity to the New Madrid Fault. Therefore, the purpose of this memo is to notify all school districts, cooperatives, and interested parties that earthquake preparedness programs are essential and should be initiated, for those who have not done so, as soon as possible. To assist with these programs the following information is provided:

1. School Earthquake Safety Program Guidebooks are available upon request.

2. Lectures and video presentations are also available for students K-12.

3. On-site inspections and recommendations for schools and districts may be scheduled.

4. All of these services are provided by the State Office of Emergency Services, P.O. Box 758, Conway, AR 72032-0758, contact person, Dan Cicirello, Supervisor, 501-374-1201.

The K-12 area supervisors will monitor these programs during their annual visits.

FEDERAL EMERGENCY MANAGEMENT AGENCY

Outstanding Public Service Award

Presented to

Dan Cicirello

For exceptional service in the public interest

In recognition of your outstanding leadership and dedication in developing and implementing a model Earthquake Preparedness Program. Your work is a credit to the State of Arkansas and reflects both personal and professional concern for the citizens who may be at risk because of the New Madrid Fault.

Acting Director

February 22, 1990

Date

Arkansas
DEPARTMENT OF EDUCATION
4 STATE CAPITOL MALL • LITTLE ROCK, ARKANSAS 72201-1071 • (501) 682-4475
BURTON L. ELLIOTT, Director, General Education Division

RECEIVED

July 6, 1992

Mr. James Lee Witt, Director
Arkansas Office of Emergency Services
P. O. Box 758
Conway, Arkansas 72032

Dear Mr. Witt:

The Governor's Task Force on Student Discipline and Safety has recommended that the Arkansas Department of Education (ADE) develop guidelines for earthquake safety in schools. I know your Agency has done extensive work in this area and I would like to borrow from that expertise. It would greatly benefit our efforts to be able to utilize the people and information in your office, therefore I am requesting your assistance.

Please let me know if this assistance will be possible and feel free to call me with any questions. Your help will be greatly appreciated.

Sincerely,

Dan Lovelady, Coordinator
School Plant Service

DL/gd

Arkansas
DEPARTMENT OF EDUCATION

4 STATE CAPITOL MALL • LITTLE ROCK, ARKANSAS 72201-1071 • (501) 682-4475
BURTON L. ELLIOTT, Director, General Education Division

RECEIVED 1992 AUG -3 P 1 01

July 31, 1992

Mr. James Lee Witt, Director
Arkansas Office of Emergency Services
P. O. Box 758
Conway, Arkansas 72032

Dear Mr. Witt:

I trust things are well at OES and probably very busy this summer. We seem to have been busier this summer than most, but it sure has passed quickly.

I wrote to you earlier requesting OES' assistance in developing earthquake safety guidelines for schools, and I wanted to tell you a little more about our plans. I would like to address three basic areas in these guidelines, and I believe your office could be of great assistance in this project. I would like to address preventive planning, hazard identification and mitigation, and student earthquake drills. I believe these areas would allow us to develop some very effective guidelines and address the most vital concerns of this problem.

I appreciate your consideration and please let me know if OES will be able to assist us in this project. Also, I will not be able to attend the DPI Conference at Lake Degray.

Sincerely,

Dan Lovelady

Dan Lovelady, Coordinator
School Plant Service

DL:gd

School Emergency Preparedness in New York State

by John DiNuzzo
Program Manager
New York State Emergency Management Office

Abstract

All school districts in New York State are required to develop emergency plans, to test these plans, and to coordinate their emergency management activities with local public safety groups. Not all school districts are taking this responsibility seriously; nor are emergency service agencies adequately planning for school emergencies. Particular shortcomings exist in the areas of emergency notification, private school involvement in local preparedness efforts, and emergency response training being provided to school administrators and teachers. Recommendations for improvements in the school emergency preparedness effort are discussed.

Introduction

School emergency preparedness initiatives in New York State have received increased attention in recent years. A series of natural and technological emergencies in the early and mid-1980's gave the Board of Regents, the policy-making body for the State education system, the impetus to require a greater emphasis on emergency planning and training. Section 155.13 of the Commissioner of Education's Regulations, which took effect in April 1989, requires detailed emergency management planning, improved emergency communications coordination, and regular testing of contingency procedures on the part of the more than 700 local school districts outside of the City of New York and the 41 Boards of Cooperative Educational Services (BOCES) districts. New York City's Board of Education was given discretion as to how to best deal with the issue.

Sadly, as school districts were beginning to comply with this new regulation, a tragedy occurred that stunned that state's education and emergency services communities. Nine pupils at the East Coldenham Elementary School were killed in the cafeteria on November 16, 1989, when the school's external wall collapsed at mid-day from a tornado force wind. Recognizing the urgency for an improved statewide school emergency preparedness program, the State Disaster Preparedness Commission began a concentrated program to assist the State Education Department and local school districts in better addressing their emergency responsibilities.

I have been privileged to serve as the manager of New York State's School Emergency Preparedness Program for the past two and one-half years. In that time, a wide range of educational organizations have been consulted, including the state's two largest teachers' unions, the state PTA, the School Boards' Association, and groups representing school district superintendents, Catholic school superintendents, school business managers, school transportation chiefs, and school buildings and grounds superintendents.

The remainder of this paper will be devoted to describing what New York State's experience has been in initiating this on-going school emergency management initiative, its future prospects, and how it relates to earthquake preparedness in our schools, the focus of this conference.

Current Status

Among Section 155.13's most specific mandates are the following:

- Each BOCES and local school district shall prepare (by October 1, 1990) and update (no later than October 1 of each subsequent year) a school emergency management plan to insure the safety and health of children and staff and to insure integration and coordination with similar emergency planning at the municipal, county and State levels. Plans are to address, at a minimum, nine specific areas, including potential emergency sites and descriptions of the systems to be used to notify all schools within a district of emergency situations.

- Each district shall cooperate with appropriate State, county and city agencies in developing agreements for the use of school-owned facilities and vehicles during a disaster. School districts and BOCES's are required to relinquish to the appropriate State or county agencies the control and use of school transportation vehicles and facilities in accordance with county emergency preparedness plans or directives.

- Each public school superintendent and each chief administrator of a non-public school shall take action to provide written information, by October 1 of each school year, to all students and staff about emergency procedures.

- Each district shall, at least once every school year, and where possible in cooperation with local emergency preparedness officials, conduct one test of its emergency plan for sheltering and early dismissal. Such drills shall test the usefulness of the communications and transportation systems during emergencies.

- The chief executive officer of each non-public school shall provide information to the local superintendent of schools about school population, number of staff, transportation needs, and the business and home telephone numbers of its key officials. The school district emergency plan must contain this information.

To assist local and regional school officials in meeting these requirements, several activities were undertaken. A "Planning Manual" and a "Checklist for School Emergency Plans" were prepared and distributed. Pilot emergency planning projects were sponsored in two school districts, one urban (Syracuse) and one suburban/rural (Guilderland). A pilot school emergency exercise conducted in the Greece (suburban Rochester) Central School District was the basis for a brochure and a ten-minute videotape devoted to the subject. Programs that trained in excess of 1,200 school officials were held at various locales in the state. Finally, the office offered to review and comment on plans voluntarily submitted to the State. Although the regulation does not require such submissions, this offer has been accepted by 30 districts and non-public schools.

Future Prospects

Great strides have been made in improving the level of school emergency preparedness in the past few years, but much more needs to be accomplished. Currently, the two greatest obstacles to these efforts are apathy and fiscal concerns. Although apathetic attitudes on the part of school officials toward their safety responsibilities seem less common now than was the case a couple of years back, the primary curriculum remains their priority. Also, as the leaders of the State Education Department and local school officials scramble to provide sufficient financial support for classroom activities in the face of funding cutbacks, emergency preparedness initiatives tend to be de-emphasized.

Given these obstacles, and the State Disaster Preparedness Commission's stated commitment to supporting school emergency preparedness activities, I was asked to present a report late last year to summarize what we had achieved to date and, what needed further attention. The following recommendations were among those adopted by the Commission in the fall of 1991, and remain cogent suggestions at this time.

1. *The Commissioner of Education's Regulations should be amended to require that BOCES and local school district emergency plans be submitted to and reviewed by that State.*

   I'm not certain of the reason that Section 155.13, as currently constituted, doesn't require the submission of these plans to the State. It may have stemmed from the Education Department's intent to keep the onus for emergency management on the districts, or perhaps the Department's general unease with the prospect of having to judge the merits of any submitted plans. Regardless, a mandate to submit these plans could motivate some of the recalcitrant districts to do a better job in developing these plans. Review and critique of plans by state emergency planning experts will only aid the process.

2. *A special effort should be made to ensure that effective emergency notification procedures exist for all school districts and individual schools.*

   Special arrangements for very localized situations, such as fires and traffic disruptions, <u>must be</u> discussed with community notification sources (e.g., the fire and police departments). In addition, workable procedures such as after-hours warnings to district personnel and emergency contacts with non-public school officials, must be developed and refined through the planning and exercise process. Finally, State recommendations that advise the monitoring, throughout the school day, of NOAA Weather Radios and battery-operated AM/FM radios by district administrative staffs should be implemented.

3. *School district officials should fully integrate those private schools within their boundaries into the district's emergency management activities.*

   Section 155.13 requires that private schools provide certain information to their local school districts for inclusion in district emergency plans. District plans must also contain descriptions of how all educational agencies, public and private, will be informed of emergencies. Given these provisions, and the desire to provide an equally safe school environment for all students and educations, school districts should work to make private school administrators full partners in their emergency management initiatives.

4. *Municipal and local emergency officials should concur in and receive copies of school district emergency plans.*

   Both State Executive Law and Education Department Regulations endorse the concept of coordinated comprehensive emergency planning efforts. It is good public relations and good practical management to involve local emergency organizations, the source of immediate response services, in the school planning process. School districts should also ensure that copies of their plans are provided to local and county officials who will play significant roles in any activation of these plans.

Earthquake Preparedness Training

New York State's approach to earthquake preparedness training in its schools has evolved from two basic assumptions. First, *the public's perception is that the state's vulnerability to earthquakes is very minor.* As one might suspect, even in parts of the state that experience tremors with some degree of regularity, earthquakes are seen as a California problem. Our second assumption is that *by ensuring that school administrators and teachers are equipped to handle all types of emergencies, they will be able to adequately deal with an earthquake.* With the East

Coldenham tragedy still relatively recent and fresh in our minds, tornados have understandably been the natural hazard phenomenon of primary concern to school safety officials statewide.

Public Perception

From its legal origins during the Cold War era of the early 1950's, Federal Emergency Management (civil defense) policy dictated that states and communities receiving Federal funds for this purpose devote a large proportion of time and energy to nuclear attack-oriented preparedness activities. As the Vietnam conflict emerged as a national source of debate and division in the 1960's and early 1970's, it became evident that "selling" emergency management on the basis of nuclear war concerns wasn't palatable to the American public. People just did not believe that nuclear war was likely to occur, nor did they feel that, if it did happen, it was survivable.

While not by any means an exact analogy, the attitude of most New Yorkers toward the idea of a devastating earthquake has many parallels to the nuclear war scenario. People find it very difficult to accept the possibility of a major quake in our state, and look warily upon governmental or scientific efforts to convince them of our vulnerability. As a result, the informal State strategy for addressing earthquake preparedness training has been based on the notion that you can't fight this perception unless (or until), the state is impacted by a serious quake. Therefore, as was done for the nuclear war issue, earthquake-specific training has been provided to a small group of individuals who will be expected to lead the response if a major quake strikes New York.

In the "Planning Manual" produced as part of New York State's school emergency preparedness effort, "Earthquake" is one of seven natural hazards for which detailed procedural guidelines are presented for school emergency plan preparers. Most school districts have adapted this guidance to prescribe what their teachers, administrators and other staff members should do if an earthquake strikes. The "Earthquake" entry in the manual was reviewed and approved by the National Center for Earthquake Engineering Research before its publication.

The "All-Hazards Approach"

Because of the perception of low earthquake vulnerability on the part of its residents, New York State's training philosophy has been to sponsor "generic" emergency management instruction that will aid responders in dealing with earthquakes as well as other types of emergencies. Existing training programs that address issues such as leadership, incident command, and emergency problem-solving skills should provide a sound basis for competent, efficient management decisions in most emergency situations. Once the earthquake itself is over, emergency response functions (e.g., search and rescue, power restoration, fire-fighting, communications and public information activities) will be handled, for the most part, as they would be for other kinds of catastrophes.

This "All-hazards" approach envisioned for earthquake response will utilize the hazard-specific expertise that exists at the New York State Geological Survey (within the State Education Department) and the National Center for Earthquake Engineering Research (NCEER), which is headquartered in Buffalo, New York. Just as the National Weather Service and the National Hurricane Center provide key advice to our state when hurricanes threaten or occur, the State Geological Survey provides perspectives on critical issues such as earthquake response priorities, the likelihood of after-shocks, etc.

Conclusions

The earthquake preparedness training program in New York State's schools is a fully integrated element of the overall school emergency preparedness effort. As was shown, we have done much to improve the level of safety in our schools in recent years, but a great deal more still needs to be accomplished.

Part V - Emergency Preparedness - More Than "Duck, Cover, Hold"

The key to promoting a successful school emergency management program lies in the word *management*. Good management, in this context, equates to being thorough in your preparedness activities: enlisting the aid of experts to determine what needs to be addressed; developing emergency plans in consultation with first responders; and using every possible forum to inform staff, students, parents and the general public of how you are planning to cope with various emergency situations.

People are at their most vulnerable in an emergency. They expect government to effectively address situations with which they can't cope on an individual or neighborhood basis. Although the public is currently unconvinced of our vulnerability to an earthquake, we must continue to be prepared to minimize the damage that would result if one were to occur. As government officials, the social contract with our residents, and with the users and employees of our school system, must not be compromised.

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(New York State-specific)

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Recorder Notes

Emergency Preparedness

by Marilyn MacCabe, Discussion Facilitator
Federal Emergency Management Agency

Bruce Berman, Recorder
New Jersey Earth Science Teachers Association

Educating children is the basic component of the FEMA program; we need to get children to then bring the word home to the adult population; emergency preparedness involves education.

Earthquake education is still a "blip on the radar screen" and states are finally beginning to come into the program; earthquake drills, etc. are being implemented, but the wheels turn slowly and it unfortunately may take a tragedy to spur action.

In Vermont...no concerted plan for even snowstorms and dealing with hypothermia, etc. let alone quakes. Maybe an overall strong, general emergency management plan is necessary first. Success in Arkansas due largely to choice of members of emergency management group who could cut red tape in developing legislation. No opposition to law being passed in Arkansas legislature because the people convinced the legislature. In New England and rest of the northeast, public awareness must first be raised to successfully get laws passed. Groundwork (information and education) must be laid first before going to public who will, in turn, push government. One advantage in Arkansas was the publicity about New Madrid fault - no strong earthquake to reference in New England (always looking to 1755 Cape Ann event). Earthquake preparedness has just started in this area.

Materials are available to introduce in classrooms and the classroom is the place to start.

Any motivational techniques to make people get started?
- Use of junior fire marshals
- Kids have looked for problems during New York water shortage; brought concept home to parents
- Use of junior "litter patrols" (prepares kids for awareness in future and gets to their parents as well)

Students can be used in emergency squads and given general training which can be applied to various disasters. Should students simply have nuturing roles (i.e. with younger kids) or be able to handle serious problems (while being protected by good samaritan laws)?

Problems to be addressed:

1. Evacuation of school because of problem inside building during very cold weather.

2. Evacuation of schools when other nearby buildings are also destroyed/unsafe/damaged.

3. Explaining aftershocks; planning drills to incorporate aftershocks.

Part VI

Concluding Issues

Planning as Though Children Mattered: Earthquake Preparedness for the Sake of Children's Security and Stability, as Well as Physical Safety

by Lydia H. Walker
National Director
Cooperative Disaster Child Care

Abstract

A school plan which begins with the understanding of children's psycho-social needs in disaster will put children first and engender support from parents and community members for active assessment and planning in their schools. This paper is intended to focus attention on the psychological impact of disasters on children and the need to take this information into account in the planning stages before a disaster strikes.

Introduction

My purpose in this discussion of the psychological needs of children in disaster is two-fold. First, I believe it is important for us, as educators and emergency preparedness specialists, to focus our attention on those concerns before a disaster strikes. A school plan which begins with the understanding of children's psycho-social needs during and after a disaster will put children first. This focus on children first (rather than all the emphases being on buildings or plans) will engender support from parents and community members for active assessment and planning in their schools. Many developmental problems and emotional disturbances suffered by children who are victims of disasters might be prevented or treated earlier if parents, teachers and other adult caregivers were provided education and skill training in how best to respond to children in times of disaster.

Second, as aware as we may be already of the need to mitigate against damage and physical injury in our schools, I do not think most of us are adequately prepared for the emotional and psychological impact of a catastrophic earthquake on the children and young people who depend on us for safety and support. I intend to suggest concepts and resources with which we can sensitize and encourage officials and staff of our local schools and communities as they develop earthquake preparedness plans. The psychological principles we will discuss apply to all life-threatening and emotionally traumatizing situations, not just earthquakes.

Children Are Vulnerable

A 1986 document published by the United Nations Children's Fund titled "Children in Especially Difficult Circumstances,"[12] discusses the needs of and assistance to children in areas torn by armed conflict and other disasters. We may think it unlikely that our disaster preparedness plans should include the eventuality of armed conflict on US territory. However, one needs to look no further than Los Angeles this past spring or the daily homicides in our nation's capitol to realize how unprepared we are to deal with the psychological aftermath of civil disorder and violence in our city streets.

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[12] United Nations Economic and Social Council E/ICEF/1986

What is this phenomenon? If it is this easy for the human community to forget or discount such disasters, then it is no wonder that it seems so difficult to plan for the psychological protection of children during and after earthquakes and other disasters. One factor is denial. We have a tendency to repress devastating and painful experiences in the first stages of the grief process. A second factor is our collective myths. At least in the so-called "first world" or the industrialized world, our social myths tend to glorify the triumphs of human beings over natural forces or overwhelming odds. One such present day myth growing out of human arrogance is the illusion that natural forces can be predicted and thereby controlled. Earlier tribal myths grew out of the need to learn from experience and teach the younger generation how to respect Spirit and Nature. A third factor is the assumption that, because young children have not developed the skills of articulating their feelings and internal experience in the language of the adult, children either do not experience stress or do not know enough to interpret their experiences as dangerous or traumatizing.

Fears and Needs of Children in Disaster

Children of all ages, but especially preschool children, depend upon adults (usually their parents) for survival. Farberow and Gordon (1981)[14] explain the impact of disaster on children utilizing the attachment theory of John Bowlby. Attachment refers to the emotional bond between the child and the nurturing figure. The child has an inborn tendency to seek to be close to the person providing the nurturing. This serves to protect the child from harm. Attachment behaviors, such as crying, calling, and clinging, enable the child to contact the provider of nurture. The readiness of the adult to respond to these behaviors helps develop a secure attachment. Attachment behavior is evident throughout an individual's life although it decreases in intensity at about age three. It is apt to be aroused when one is sick, tired or fearful. Young children are prone to extreme distress when their attachment figure is not available. This distress is called separation anxiety.

A disaster is a situation that suddenly threatens the safety and security of a child, and therefore evokes the need to be close to the attachment figure. A disaster provokes extreme separation anxiety. The more severe a disaster, the greater the threat of actual separation. During a disaster and in the aftermath, children are likely to be afraid of being alone or in the dark, or hearing loud noises, or of experiencing sudden movements.

Children's greatest fears are that they will be separated from the parent or nurturing caregiver, that they will be injured (or re-injured), and that there will be a reoccurrence of the threatening event.

Symptoms of Stress and Trauma

Children suffering from any of the above fears will show one or more symptoms of their fear and anxiety, depending various factors. A child's ability or inability to cope depends on the degree of exposure to the disaster, their individual developmental level, history of prior loss or trauma, the family's reaction to the disaster and support or lack of support for the child, prior economic conditions, etc.

Two major indicators of emotional distress were identified by Faberow and Gordon (1981): change and regression. Change occurs when behaviors, reactions, and methods of doing things become atypical, such as changing from being independent to becoming clinging. Regression is displayed when the child returns to a behavior typical of an earlier developmental stage, such as thumb sucking or bedwetting. Other stress symptoms include sleeping or eating problems, recurring dreams about the event, withdrawal from relationships, confusion, physical complaints or school problems.

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[14] Faberow, N. & Gordon, N. (1981). Manual of Child Health Workers in Major Disasters. DHHS Publication No. (ADM) 81-1070.

What Do Children Need?

The young child needs to be reunited with the family as soon as possible, if it is possible. Studies have shown that children who were separated from their families and sent away to the country from their families for safety reasons experienced more severe trauma than those who stayed with their families during the bombing of London. To a young child, fear of abandonment is greater than the fear of injury or death. However, lacking this option, the child needs a consistent, accepting, comforting relationship with a caring, understanding adult or family. Children need to know that they will be protected from harm and that they will not be left alone. A child, separated from family, should not be moved from person to person, or place to place, except for reasons of physical safety.

When an earthquake occurs during school hours, parents will rush to the school to be reunited with their children. Careful planning by the school ahead of time for family reunification, can prevent a secondary disaster. Brothers and sisters in different classrooms or attending different schools will want to find each other. Again, establishing policy and procedures and practicing the plan can prevent additional traumas from occurring.

Children need a receptive listener for their feelings. Children find validation or (invalidation and disapproval) reflected in the words and non-verbal responses of the adults around them. If they are to make sense out of a painful and chaotic experience, they need positive experiences of acceptance, not judgment, from the adults around them. Children need an opportunity for expression and ventilation of their feelings. The child's internal experience and emotional responses may find expression in story-telling through painting, drawing, sculpting clay, puppets, or reenactment of the drama they witnessed. Most important of all is finding a sense of security in caring adults who accept them just the way they are and assure them that they will be kept safe from harm. It is not necessary for a person to be a child therapist to simply listen and receive a child's expressions without judgment. Of course, it is necessary to protect a child from behavior that is dangerous or self-destructive. However, the aftermath of a disaster is not the time to try to correct behaviors or teach new skills.

Programs for Children

In 1979, the United Nations Year of the Child focused attention on the basic rights of all the world's children. One of these was the right of the child to "be among the first to receive aid in times of disaster." In the United States, churches, disaster organizations, schools and the mental health community began to notice the lack of specific services for children following disasters.

In 1980, The Church of the Brethren established Disaster Child Care as a part of their Disaster Response Services. In 1984, a number of additional major denominations came together to support these child services to children in disaster and Cooperative Disaster Child Care was formed. This national voluntary agency provides specialized child care within American Red Cross and Federal Application Centers. Both the training for volunteers and set up of the child care centers are based on principles outlined in the 1981 Manual for Child Health Workers in Major Disasters. While they file for assistance or attend to recovery, parents can leave their children with skilled volunteers who will give then emotional support and focused attention. Since 1980, research and publications about the effects of disaster on children have expanded greatly.

Now, many school systems across the USA have begun to put Crisis Intervention Teams in place to respond to student deaths and other school crises. These professional teams are made up of school psychologists and guidance counselors, community mental health professionals and others who serve children and youth and have psychological training. Literature is increasingly available for lay persons as well as the professionals which describes ways to understand and help children cope with stress and disaster. Local and state Red Cross chapters and mental health services have published booklets for parents.

Since 1991, the American Red Cross and the American Psychological Association have been working together to develop a network of licensed psychologists who are specially trained to provide counselling services on disaster sites, not only to survivors in need of support, but also to disaster workers who are experiencing the stress of the disaster situation.

FEMA (Federal Emergency Management Agency) includes in their Earthquake Safety for Schools Program sections on emotional and psychological needs after disasters. This important aspect of planning is being introduced to the many school personnel from across the USA that have attended these training program. Children and Trauma, the School's Response, is an excellent video available from FEMA, which addresses the needs of the school-age child in the aftermath of disaster. It is clear that a trend has started and planning for the psychological needs of children in school preparedness, whether for earthquakes or for any other emergency that may occur has begun. This is a hopeful sign. Yet, we are far from being ready to provide adequate emotional support for all our children in a major catastrophic event.

Summary

Collective pyscho-social memory is short-lived. People must continually be reminded of and re-educated as to the long-term negative effects caused by the failure to plan for the psychological protection of children during and after earthquakes and other disasters.

Planning and prevention makes "good business" sense. Aside from one's personal or parental concern for the safety of our children, several practical reasons will be identified for why a community should a) **develop and "dry-run"** plans that can prevent costly injuries and psychological trauma, b) **prepare** school personnel to deal effectively with emotional reactions and to know when to refer children who have been traumatized, c) **understand** how to stabilize and "normalize" as quickly as possible after a disaster, d) **eliminate** "crisis management" as the typical response mode in a disaster.

Planning as though children mattered is more than the social worker's agenda. It should be a moral imperative as it could affect the long term health and survival of our nation. Schools can lead this endeavor by providing new, more effective models of earthquake preparedness based on the belief that the purpose of community disaster planning is not simply to save lives and count bodies. At the very heart of the plan will be the intention to preserve the social and emotional integrity of the community and to provide support for the healing process of children and families after disaster.

Acknowledgments

Cooperative Disaster Child Care, 500 Main Street, New Windsor, Maryland, 21776, Cooperative Disaster Child Care Volunteer Training Manual, Rev. 1992, for material on children's responses to disaster.

Dr. Karen Doudt, Associate Professor of Education at Manchester College, North Manchester, Indiana, who was instrumental in developing the training program for disaster child caregivers at the inception of the Church of the Brethren Disaster Child Care Program.

Marilyn McCabe, Federal Emergency Management Agency, Office of Earthquakes, Washington, DC, for support of the inclusion of sections on psychological needs in the Earthquake Preparedness for Schools Course.

Additional Resources

Childhood Stress. Wiley Interscience Series. John Wiley, & Sons, N.Y. Current research covering all aspects of stress on children, pre-schoolers, and adolescents.

Manual for Child Health Workers. Norman L. Faverow and Norma S. Fordon, National Department of Mental Health, U.S. Department of Health and Human Services, U.S. Government Printing Office.

Trauma in the Lives of Children: Crisis and Stress Management Techniques for Teachers, Counselors, and Student Service Professionals. Kendall Johnson, Ph.D., published by Hunter House, Inc., P.O. Box 847, Claremont, CA 91711.

When Lightning Strikes; Trauma and Its Aftermath, The Family Networker, November-December 1991.

Stress Interventions with Adolescents

by Lydia H. Walker
National Director
Cooperative Disaster Child Care

Some Assumptions About Adolescents and Stress

- The normal developmental tasks of this age group are focused on ego development. Youth ask themselves questions such as "Who am I as a person independent of my parents?" They also are building peer relationships, and learning relationship skills not only with peers but with adults outside of the family. Most youngsters experiment with sex and bonding during these years.
- Skill building for achievement and performance in the adult world is taking place in the school, in social groups, or in the streets.
- These years have built-in "normal" stressors such as peer pressure, family pressure, and school pressure. For adolescents, internal conflicts arise from developing sexual maturity and pressures to achieve.
- Many external pressures affect youth: mass culture, the market and advertising, the media, and international politics. Advertisers are very aware of the need for youth to have a sense of belonging and acceptance.
- Normal teenagers are at risk in our society.
- Exposure to catastrophic events *adds* to existing stress.

Stress Related Disorders of Adolescence

Several stress-related disorders are prevalent among adolescents.

- Adolescent depression and suicide
- Dysfunctional or pathological developmental and psychological models
- Substance abuse
- Eating disorders
- Over-achievement and burn-out

Symptoms of Post-Traumatic Stress Disorder

Disaster survivors may experience post-traumatic stress disorder (PTSD). Adolescents with PTSD may show the following symptoms:

- Poor impulse control
- Disenchantment and rebelliousness
- Suicidal behavior
- Truancy
- Delinquency
- Bad judgment
- Life-threatening re-enactment behavior
- Drug abuse
- Sexual indiscretion
- Interpersonal relationship problems

Determining Potential Choice Points

Counselors, teachers, and other resource workers can be instrumental in recognizing when an adolescent needs intervention in dealing with the impact of a disaster. The following story about Cathy illustrates the type of incidences to monitor to determine if an adolescent needs help.

Critical Choice Points in the Life of an Adolescent: *Cathy's Story*

Daughter - Cathy, a student
Mother - Carol, a registered nurse
Father - Joe, a store operator
Brother - Joey, a student

In 1973, there was a flood in West Virginia that damaged Cathy's home and destroyed a small store her father operated as a family business. The family recovered from the disaster with financial help from the mother's family. With this assistance, they relocated to the town of Petersburg, West Virginia, and rebuilt their home and business. The father, Joe, started working at his new store. The mother, who had been a homemaker, returned to work at an area hospital. In November 1985, another major flood occurred and the town of Petersburg was almost wiped off the map. Again, the family lost everything.

A few years before the second flood, the father had started to exhibit alcoholic behavior. Driving while intoxicated one night, he wrecked the family car and was hospitalized. Cathy was sent to stay with a neighbor during this period because her mother went to visit the father every night in the hospital. Joey assumed some of the parental roles by taking care of things around the house. He was alone and things needed to be done. When the father left the hospital, he went on disability and quit working. The whole family then moved in with Carol's parents. Around the same time, the family left their church, because the Pastor had started calling non-believers Satan-worshippers and making other statements with which the family did not agree.

All through these crises, both Cathy and Joey excelled in school-related activities, earning good grades and participating in sports. Cathy became a champion member of the high school swim team. Joey left for college in 1988. The mother told Cathy she hoped she would do as well as her brother.

Although the crisis period seemed to have ended temporarily for the family, in Cathy's own life, the events continued. While in high school, Cathy witnessed a knifing in the schoolyard. In addition, she was picked up for drunk driving one weekend while out with a group of friends. At home, the reaction she faced to her drunk driving charge was a disaster in itself. Her father became very angry, and blamed Cathy's friends for the incident. Surely his own daughter would never do such things on her own! He also blamed his wife for overprotecting Cathy, and said this was the reason Cathy got into trouble.

None of these events stopped Cathy's achievements. She kept doing well in school both academically and athletically. After graduating from high school, Cathy entered college. There, her high achievement continued and she tried out for the U.S. Olympic swim team.

Finally, however, the effects of the past years' turmoil manifested themselves in Cathy's life. One evening, during her sophomore year in college, the family received a call from their daughter: "Mom, Dad," she said, "I'm very sick. I've been diagnosed as having an eating disorder and I want to drop out of school for a while and come back home."

Recognizing Critical Choice Points

There were a number of critical choice points in Cathy's life, i.e., the points when intervening adults could have helped Cathy make critical choices and provided support for the difficult times she faced.

- The number of moves (There were five in all. The family had to move three times. Cathy moved two additional times: when she went to stay with the neighbors during her father's hospitalization and when she started college).
- Natural disasters - the floods
- Her father's hospitalization
- Her father's alcoholism
- Her father's inability to work
- Her mother's return to work
- Moving in with the extended family

- The constant financial strain caused by the loss of family businesses
- Her brother's going off to school
- Leaving the family church
- The schoolyard knifing trauma
- Her driving while intoxicated charge
- Her father's blaming Cathy's mother for their daughter's problem
- Her mother's expectation that Cathy live up to her brother's standards

It was discovered later that Cathy had been sexually abused at the age of 10 when she lived with the neighbors. Cathy had repressed the abuse completely. When it surfaced, she became angry with her mother and said she did not trust her.

These would be the kind of events that could alert school personnel to potential problems and should prompt intervention by school counselors. It is important that school personnel not think that the parents alone should handle a child's problems. Neither should parents believe that school counselors are solely responsible for crisis intervention in an adolescent's life.

Factors in Adolescent Response to Stress

Several factors will affect an adolescent's response to stress. The following coping skills can help determine how adolescents will handle a disaster.

- Cognitive ability
- Persistence
- Social competency (ability to develop satisfying peer relationships and sustain friendships)
- Activity competency
- Problem-solving skills
- Ego resiliency

1. In relation to this story, Cathy showed some strengths and weaknesses in terms of coping skills.

   Strengths - Cathy was persistent and had a great deal of cognitive ability and activity competency

   Weaknesses - Cathy's weaknesses were found in her problem solving ability. Cathy was unable to deal with the losses she had recently experienced in a direct way. She showed this in her obsession with school athletic achievement. Teachers were not aware of her problems, because she seemed to be doing very well. This type of overachievement is often seen in compulsive achievers who commit suicide. Because children may not always give clear signs of emotional problems, adults must always pay attention to their own blind spots and biases when trying to understand adolescent behavior.

2. Family cohesion or conflict

   Cohesion - In Cathy's situation, her family stayed together despite the conflict they faced.

   Conflict - Substance abuse (drinking) by Cathy and her father can be seen as a symbol of relationship problems. These family relationship problems became evident when Cathy called to tell her parents about her eating disorder and to let them know she would be coming home from school. Her father responded by saying to his wife, "I'll go and get Cathy and bring her back. You're part of the reason she's in this condition." When Cathy talked to her mother, she told her, "I'd like you to come to bring me home. Mom. Please don't let Dad come. He's part of the problem."

3. Development of (or lack of) internal locus of control (belief in one's personal efficacy and control) - Families now depend on schools to foster self confidence and self control in students. However, these characteristics must also be encouraged at home. Development of an adolescent's internal locus of control must be supported in all aspects of the environment.

4. Defense mechanisms (level of maturity) - Adolescents have various ways of expressing their developing identities and differentiating themselves from their parents. They may do this by many means.

   - By who they choose as friends
   - The way they dress
   - Their means of gaining acceptance in peer groups
   - Their working to earn money for personal needs can be seen as a way to have control over their life.

Criteria for Interventions

The following questions may be used as criteria in tailoring interventions to meet the needs of adolescents.

- Does it undermine or support the person's ego development? Ask yourself "Does it promote the adolescent's well-being or take away from whom they are?"
- Does it isolate or promote the well-being of the family? In some cases, the best intervention is to isolate a child from the family if extreme circumstances are harming the child.
- Does it rescue and inappropriately "protect" the person or does it offer opportunities for them to practice competencies and influence the outcomes?
- Does it build coping skills and offer opportunities to learn?
- Does it provide stability and bring normalcy to their day-to-day life?

- Does it support healthy peer relationships? Some interventions set kids apart from the group. A counselor or teacher must consider if removing a child from a familiar group will make the child's situation better or worse.

- Does it attack their defense mechanisms or build trust?

- Does it call forth the best in the person, their desire to be involved, or to serve others?

- Is it appropriate within my role (teacher, counselor, administrator, etc.)?

Steps and Options

The following steps and options can help resource workers heal the impact of disaster.

- Recognition of symptoms

- Diagnosis

- Referrals/interprofessional collaboration

- Self-help groups/in-school therapy group - Children might be more receptive to drawing. Adolescents, however, respond well to drama and music.

- Family interventions

- Classroom activities
  - learning about stress
  - research about disasters
  - self-expression and enjoyment through art, music, drama, and writing
  - community service projects

Effects of Disaster on Child and Family

by Lydia H. Walker
National Director
Cooperative Disaster Child Care

Children of all ages, but especially preschool children, depend upon adults (usually their parents) for survival. Farberow and Gordon (1981) explain the impact of disaster on children utilizing the attachment theory of John Bowlby. Attachment refers to the emotional bond between the child and the nurturing figure. The child has an inborn tendency to seek to be close to the person providing the nurturing, and serves to protect the child from harm. Attachment behaviors such as crying, calling, and clinging, enable the child to contact the provider of nurturance. The readiness of the adult to respond to these behaviors helps develop a secure attachment. Attachment behavior is evident throughout an individual's life although it decreases in intensity at about age three. It is apt to be aroused when one is sick, tired or fearful. Young children are prone to extreme distress when their attachment figure is not available. This distress is called separation anxiety.

Farberow and Gordon (1981) further explain that there are several naturally occurring "clues that indicate the possibility of danger: isolation, exposure to strange people or strange situations, darkness, sudden movement, or noise" (p. 8). When children are thus frightened, they withdraw to be close to their attachment figures.

A disaster is a situation that suddenly threatens the safety and security of a child, and therefore evokes the need to be close to the attachment figure. Separation anxiety can be expected to be highly visible during such a period. The more severe a disaster, the greater the threat of actual separation. During this period, it is expected that children will be afraid of being alone, in the dark, hearing loud noises, or of experiencing sudden movements (Farberow & Gordon, 1981).

A review of the literature supports the expected changes of behaviors as outlined above. Blaufarb and Levine (1972) reported that the most common problem for three- to twelve-year-old children after an earthquake was a fear of going to sleep in their own room, while for three- to six-year-old children, the common fear was of being alone. Bloch, Silber, and Perry (1956) noted symptoms of increased dependency, clinging, remaining close to home, asking to sleep with their parents, night terrors, irritability, sensitivity to noise, and phobias. Krim (1976) agreed, after studying victims of fires in New York City, adding to the list: guilt reactions, aggression, and family disorganization and breakup. Doudt (1985) studied 130 children, ages three to five, after tornadoes in North Carolina in 1984. She found significant behavioral changes in all age groups, with two behaviors - fear of loud sounds and fear of wind - markedly increased in more than half the subjects.

Farberow and Gordon (1981) explain that parents will note two major indicators of emotional distress in their children: change and regression. Change occurs when behaviors, reactions, and methods of doing things become atypical, such as changing from being independent to becoming clinging. Regression is displayed when the child returns to a behavior typical of an earlier developmental stage, such as thumbsucking or bedwetting.

Boore, Earle, and Aptekar (1990) have submitted an unpublished study of the psychological effects of disaster on children and their families in the 1989 dual disasters of Hurricane Hugo and the Loma Prieta earthquake. Although the adults reported almost equal stress in both situations, the children who experienced the earthquake reported more stress than those who experienced the hurricane. Gender, previous disasters, and separation appeared to have no effect upon the amount of stress experienced. Birth order and prior problems did show some tendency to effect the amount of stress experienced. It is unclear if the differences found between the earthquake and the hurricane could have been regional. More studies of these disasters are indicated.

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An Overview of Earthquake Resources for Schools

by Marilyn P. MacCabe
Earthquake Education Program Manager
Federal Emergency Management Agency

Abstract

During the past ten years, FEMA's Earthquake Education Program has been proactive in sponsoring community outreach projects and providing educational materials and training opportunities for a variety of audiences. FEMA's education program for schools includes workshops and guidance materials on crisis intervention and on preparing school earthquake safety programs. FEMA also conducts and sponsors "Tremor Troop" workshops for teachers. The workshops demonstrate the use of **EARTHQUAKES - A Teacher's Package for K-6** - a collection of multidisciplinary, hands-on classroom activities developed for FEMA by the National Science Teachers Association. The curriculum is designed to promote scientific literacy among young children and give them the information and skills they need to cope safely during and following an earthquake. The following is a complete list of FEMA's resources for school earthquake safety and education programs.

FEDERAL EMERGENCY MANAGEMENT AGENCY

School Earthquake Safety & Education Program

Publications

FEMA 220 School Intervention Following a Critical Incident

This 20-page booklet presents a broad overview on how a school might work with mental health professionals to put together a *Crisis Counseling Program* for the entire school community.

FEMA 219 How to Help Children After a Disaster

A team of educators and child mental health professionals developed this 17-page guidebook for teachers. It includes several classroom activities using drawing and talking methods to help children cope with the disaster.

FEMA 159 EARTHQUAKES - A Teacher's Package for K-6 Grades

Also known as *Tremor Troop*, this 280-page package was developed by the National Science Teachers Association. It contains hands-on classroom activities that support virtually all elementary subject areas. Designed for the classroom teacher with little or no background in earth science, the six-unit package focuses on:

- Defining an earthquake,
- Why and where earthquakes occur,
- Physical results of earthquakes,
- Measuring earthquakes,
- Recognizing an earthquake, and
- Earthquake safety and survival.

The *Teacher's Package* includes Background, Earthquake Legends, Scope and Sequence Charts, and Line Masters.

FEMA 149 Seismic Considerations: Elementary and Secondary Schools

This 102-page (including appendices) guidebook was prepared by the Building Seismic Safety Council. It presents the cost and benefits of applying seismic design in the construction of new school facilities. It also explains how school buildings are damaged by earthquakes, and how damage occurs to nonstructural components and building contents.

FEMA 88 Guidebook for Developing a School Earthquake Safety Program

This 50-page guide is designed to assist the school community of principal, teachers, staff, students, and parents develop and tailor an earthquake safety program for their school.

The guide takes a step-by-step approach to:

- Identify potential earthquake hazards.
- Prepare and conduct earthquake drills.
- Plan for immediate response and care.
- Develop communication plans, and
- Plan for 72-hour shelter and care.

FEMA 88a Earthquake Safety Activities for Children

This 4-part (52-page) booklet contains excerpts from Units 5 and 6 of EARTHQUAKES - A Teacher's Package for K-6 (FEMA 159). It provides classroom activities designed to prepare students to cope safely when an earthquake occurs. The booklet covers:

- What happens during an earthquake,
- Hazard hunts,
- Assembling emergency kits, and
- Earthquake simulation and drills.

FEMA 74 Reducing the Risk of Nonstructural Earthquake Damage: A Practical Guide.

This is one of several illustrated guides depicting ways to reduce or eliminate risks from earthquake damage to equipment, furnishings, and unsecured objects.

Videos

Children and Trauma - The School's Response
[20:30 min.]

A program for mental health professionals, school administrators, and teachers; it presents: trauma's impact on children and schools, normal and prolonged stress responses, assessment considerations, and intervention models.

SCHOOLS AND EARTHQUAKES - Building Schools to Withstand Earthquakes [14:27 min.]

Cost is often the overriding factor in decisions to implement seismic safety policies. This video conveys the lifesaving and economic benefits of including earthquake-resistant design in new school construction. The video complements *Seismic Considerations: Elementary and Secondary Schools (FEMA 149)*.

The following two videos will not be available until 1/15/93.

CRITICAL TIME - Earthquake Response Planning & Schools [14:00 min]

This video discusses the responsibilities of school administrators, teachers, and staff to acquire the knowledge and skills needed to protect and care for the student population until outside help is available. The video complements the *Guidebook for Developing a School Earthquake Safety Program (FEMA 88)*.

Reducing Nonstructural Earthquake Damage - A Practical Guide for Schools [13:00 min.]

This video identifies major nonstructural hazards in school buildings, and suggests simple and inexpensive ways to reduce those hazards. The video complements *Reducing the Risks of Nonstructural Earthquake Damage (FEMA 74)*.

Distribution of publications and videos is limited to one free copy per school while supplies last. Send single copy requests on school letterhead to:

Marilyn MacCabe
FEMA - Earthquake Education
Washington, D.C. 20472

Workshops

Train-The-Trainer Workshop

on

EARTHQUAKES - A Teacher's Package for K-6

June 21 to 25, 1993 ♦ Emmitsburg, Maryland
July 26 to 30, 1993 ♦ Emmitsburg, Maryland

This *hands-on* workshop is designed to demonstrate the use and benefits of the *Teacher's Package (FEMA 159)*. The workshop also includes a unit on *Crisis Intervention*, focusing on the needs of children and school personnel, and a unit on *School Earthquake Safety Planning*.

Participation at the workshop is limited to 36 educators whose functions include providing in-service workshops to elementary teachers and/or recommending curriculum. Their titles may include: Elementary Science Coordinator, Elementary Curriculum Coordinator, Elementary Science Consultant. We also welcome elementary classroom teachers and regional resource center personnel.

School Earthquake Safety Program Workshop

March 22 to 26, 1993 ♦ Emmitsburg, Maryland
July 12 to July 16, 1993 ♦ Emmitsburg, Maryland

This workshop is largely based on the *Guidebook for Developing a School Earthquake Safety Program (FEMA 88)*. Instructional topics include: Hazard Identification, Earthquake Drills, Immediate Care and Response Requirements, Psychological Responses and Needs; Communications, Sheltering, Long Term Recovery Considerations, Hazard Mitigation Measures, and Planning.

The intended audience for this workshop includes: school district administrators, principals, school board members, district facility and risk managers, school nurses, and teachers.

♦ ♦ ♦

For further workshop information and application, contact:
Joseph Sills
Emergency Management Institute
16825 W. Seton Avenue, Emmitsburg, MD 21727.

Where Do We Go From Here?
The Next Step

by Katharyn E. K. Ross
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Daniel Catlett
Earthquake Program Manager
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Marilyn MacCabe
Earthquake Education Program Manager
Federal Emergency Management Agency

Abstract

This workshop is not meant to be an end in itself, but the beginning of more concentrated earthquake education efforts in the northeastern part of the United States. This joint presentation will focus on upcoming earthquake education activities in the Northeast and give a general framework for those planning training in their particular school district. Problems that might be encountered along with possible solutions will also be presented. The following worksheets are meant to serve as a guide.

Framework for Planning for an Earthquake Workshop in Your Educational Setting

This is meant as a guide for planning further earthquake education activities in your educational setting. Although it is focused on providing a workshop, other activities can be planned as well, depending upon current needs. This is intended to be used for notes and planning.

1. What group or groups would receive the training? (pre-service teachers, curriculum specialists, principals, grade level teachers). Consider in your school or district, where should training start? Does it need to begin with administration in order to filter down to classrooms? Should all individuals receive training simultaneously?

2. Who would be the trainers? (teachers, curriculum specialists, principals, college/university staff, workshop participants). Do you have any teachers who have taught about earthquakes? Tried earthquake drills? Worked with particular groups of students?

3. Where would the training be held? (local school, school district office or training center, college/university, hotel)

4. How long would the training last? (one hour, half-day, full-day, more than a full-day)

5. What would be the key components of the training session? (curriculum package overview, content presentation, activities, demonstration with students). This depends on the point you are at and whether you have had other related (or plan to have) in-service training.

6. What individuals might serve as earth science experts to advise and assist with the workshop planning and presentations? (high school science teachers, college/university staff, science curriculum specialists, local s.ientists).

7. What might be some of the costs of providing a workshop and what group or groups might provide the funding? (travel, refreshments, teacher release time/substitutes, obtaining a site for the workshop, obtaining copies of the curriculum, honoraria for presenters and participants, workshop supplies).

8. What key individuals would need to be contacted to arrange the workshop? (superintendent, supervisor of instruction, curriculum specialist, principal, consultant)

9. What problems might you encounter in organizing, arranging, and presenting the workshop? What are some possible solutions to the problems?

PROBLEMS	POSSIBLE SOLUTIONS
1. Other curricular areas might have high priority.	
2. Parent opposition from those who feel that children are going to be needlessly scared.	
3. Lack of curricular resources.	
4. Difficulty of sharing knowledge with all that need to know it (parents, teachers, school bus drivers, etc.)	
5.	
6.	

10. Develop a workshop time line including planning, implementing, and following-up with participants.

Summer	
Fall	
Winter	
Spring	
Summer	
Fall	

Appendices

Speaker List

Conference Planning Committee List

Exhibitor List

New England Earthquake Fact Sheets

Program and Schedule

Evaluation Summary

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"Earthquakes in the Northeast: Are We Ignoring the Hazard?"
September 25-26, 1992

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"Earthquakes in the Northeast: Are We Ignoring the Hazard?"
September 25, 26, 1992

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New England Earthquake Fact Sheets[15]

Earthquake History:

New England has had a history of earthquakes including those recorded by the first settlers, and by the Plymouth Pilgrims in 1638. Of the 4498 earthquakes recorded in the Northeast Earthquake Catalog through 1988, 1194 occurred within the boundaries of the six New England States, as follows:

New England States' Historical Earthquake Record to 1988

State	Years of Record	No. of Earthquakes
Connecticut	1568-1988	134
Maine	1766-1988	385
Massachusetts	1627-1988	313
New Hampshire	1728-1988	262
Rhode Island	1766-1988	31
Vermont	1843-1988	69
		1194

New England Earthquakes Since 1924 with Magnitudes 4.5 or Greater

Location	Date	Magnitude
Ossipee, NH	Dec. 20, 1940	5.8
Ossipee, NH	Dec. 24, 1940	5.8
Dover-Foxcroft, ME	Dec. 28, 1947	4.5
Kingstown, RI	June 10, 1951	4.6
Portland, ME	April 26, 1957	4.7
Middlebury, VT	April 10, 1962	5.0
Near NH-Quebec Border, NH	June 15, 1973	4.8
West of Laconia, NH	Jan. 19, 1982	4.7

Between 1924 and 1988, there have been 24 earthquakes in the Northeast with a magnitude of 4.5 or greater on the Richter scale. Of these, the above eight were within the six New England States and the other 16 within New York or the Province of Quebec were so close and strong that they were felt throughout New England.

Regional Seismic Hazard from an Earthquake

The shaking from earthquakes does not stop at state boundaries. The surrounding areas of New York, Quebec and Newfoundland also have earthquakes which impact the New England States. It is generally recognized that earthquakes in the Northeast are felt over greater distances, some four to 10 times greater, than in California.

A magnitude 6.0 earthquake in Ossipee, NH would result in a Modified Mercalli Intensity (MMI) at the epicenter area of about VIII for buildings on average foundation conditions and as high as X if on poor soils. At an MMI =

[15]This information is provided by the New England States Earthquake Consortium (NESEC), 501 Islington Street, Portsmouth, NH 03801.

VIII, chimneys, columns, towers and trees fall, and buildings are extensively damaged. At an intensity of X, large parts of even well built masonry structures would collapse while others would be knocked off their foundations. Additionally, buried pipelines would be torn apart or crushed, bridges would likely be unusable, and dams and dikes would be seriously damaged[1].

Regionally, a magnitude 6.0 earthquake in Ossipee, NH, would cause all of the states of Vermont and Massachusetts and a large area of Maine to experience an MMI equal to V for those structures on average foundations. An MMI = V would cause some buildings to tremble with resulting breakage and overturning of objects. However, if the foundations are on fill, loose sand, silt, or on stratified deposits, they could feel an intensified effect of up to a MMI of VII. With an MMI = VII, people would find it difficult to stand, chimneys and walls would crack, some embankments may slide, books and pictures would fall, furniture would overturn, moderately heavy furniture would move, pottery and windows would break, and paster and stucco would fall in considerable amounts.

The 1988 earthquake in Quebec registered 5.8 and was felt throughout New England. The magnitude 5.8 earthquakes on December 20 and December 24, 1940 at Ossipee, NH, shown in the previous table, were felt throughout New England. One study of these quakes suggested that they were felt over an area of 300,000 to 400,000 square miles. Even Vermont, which is mistakenly thought of as "earthquake free," experienced a magnitude 5.0 on April 10, 1962 and has felt the vibrations from the 402 earthquakes recorded in the northeast earthquake catalog through 1988, that have occurred immediately outside her borders in New York State and the Montreal region of Quebec. Additionally, vibrations were felt from earthquakes in neighboring New Hampshire and Massachusetts.

Locations of New England Earthquakes

Seismologists have established that the New England earthquake epicenters do not follow the major Paleozoic faults of the region, nor are they confined to particular geologic structures or terrains. So, in general, New England's earthquakes have no known relationship to the faults in New England. This condition is completely opposite to that in California. In New England, earthquakes occur all over. No one can say with certainty that they will occur in a specific location.

New England is about in the middle of the North American Plate. One edge of this plate is at the Pacific edge of California, the other is just past the middle of the Atlantic Ocean. The earthquake mechanism is still an unknown, but this plate is in compression and New England's earthquakes appear to be the result of the cracking of the surface due to buckling of this plate. There are forces on this plate to help initiate the buckling; the downward weight of the mountains and the upward stress relief as a result of the retreat of the glaciers.

Given the above, and based solely on known past earthquake activity, the three most likely source areas for earthquakes with damage potential are: eastern Massachusetts and the Cape Ann area; central New Hampshire in the Ossipee area; and the La Malbaie region of Quebec.

Probability of an Earthquake in New England

Seismologists have calculated the odds of an earthquake with a magnitude 6.0, similar to the 1755 Cape Ann quake at 1/300 per year. Additionally, the odds on a potentially damaging earthquake of magnitude 5.0 or greater is 1/20 per year. These probabilities are based on only the recent catalog data and are for an earthquake anywhere in New England. While these are considered moderate to low seismic risks, the seismic hazard from the type of subsurface soils beneath the buildings and the seismic vulnerability as a result of the type of building and its materials, must also be considered. The following values, taken from a table computed by Dr. John Ebel, Weston Observatory, represent the probability of a particular magnitude earthquake in the specified time period.

Magnitude	Probability	Years	Magnitude	Probability	Years
4.6	51%	7	5.0	38%	10
4.6	64%	10	5.0	91%	50
4.6	99%	50	5.0	99%	100
5.5	60%	50	6.0	50%	100
5.5	84%	100	6.0	75%	200

Maximum Credible Earthquake Magnitude for New England

Based on statistical studies of the known earthquakes that have occurred in New England, seismologists have also estimated the maximum credible earthquake event that they expect in the areas of the largest known past earthquakes. This data is summarized in the following table:

Area	Largest Historical Event			Maximum Credible Event	
	Date	I_{max}	m_b	I_{max}	m_b
Off Mass. Coast	1755	VII	5 3/4**	VIII	6 1/4
Ossipee, NH Area	1940	VII	5.4	VIII	6
La Malbaie, PQ Area	1925	VIII	6.6	IX	7 1/4

where: I_{max} is the maximum Modified Mercalli Intensity (MMI) value for normal foundation conditions but, depending on the immediate subsurface soil conditions, could be up to two (2) intensities higher, and
m_b is the magnitude.
** estimated

New England Seismic Vulnerability

New England is particularly vulnerable to injury of its inhabitants and damage because of its built environment. Only two New England States currently include seismic design in their building codes. Massachusetts introduced earthquake design requirements into their building code in 1975 and Connecticut very recently did so. However, these are for new buildings, or very severely modified existing buildings. Existing buildings, bridges, water supply lines, electrical power lines and facilities, etc. have rarely been designed for earthquake forces. So, although New England is considered to have a moderate seismic risk, in general it has a high seismic vulnerability because of the built environment.

One of the major concerns with this built environment is with the unreinforced masonry buildings throughout New England, including the classic mill building. This structure is amazingly strong and stiff for the normal vertical loads it was built to carry. But brick is a brittle material and masonry walls will not do well with the horizontal forces that will act on it in an earthquake if it is not reinforced or braced in some manner. A major concern with wood framed homes is to insure that they are connected to their foundations.

Earthquake Behavior

There are steps that can be taken, both short and long term, that can reduce injuries and loss of life. Initially, the most important is the person's behavior in an earthquake. The motto is, "Duck, cover and hold." Duck under a table if at all possible; do NOT run out of the building. Get yourself under cover as much as possible; even a chair if nothing else is handy. And HOLD; hold on to the table or chair. Otherwise it may bounce away from you, removing your cover. The Loma Prieta earthquake lasted less than 20 seconds. There is no time to waste!

There are many other preparedness activities you can do. Look around for all the loose items, and weakly connected items which can fall or be thrown at you. The New England States Earthquake Consortium (NESEC) has literature from the Federal Emergency Management Agency (FEMA) which shows what to look for. Contact FEMA or NESEC for free copies.

Additional Earthquake Information and Assistance Resources

Regional State Earthquake Program Managers:

Gregory B. Champlin
NH Office of Emergency Management
State Office Park South
107 Pleasant Street
Concord, NH 03301
(603) 271-2231

Edward B. Von Turkovich
Division of Emergency Management
103 South Main Street
Waterbury, VT 05676
(802) 244-8721

Robert F. O'Brien
RI Emergency Management Agency
State House Room 27
Providence, RI 02903
(401) 421-7333

John C. Smith
Emergency Management Agency (MEMA)
400 Worcester Road
Post Office Box 1496
Framingham, MA 01701-0317
(508) 820-2000

FEMA Region I Office:

Daniel N. Catlett
Natural Hazards Program Specialist
Room 462, John W. McCormack POCH
Boston, MA 02109
(617) 223-9561

Program and Schedule

AGENDA - DAY ONE - Friday, September 25, 1992
SETTING THE STAGE

Noon-2:00 PM	**Registration** - *Great Bay Foyer*	
2:00-2:45	**Welcome** - *Great Bay Room* Introductions NCEER, FEMA, NESEC Opening Remarks - Meeting Objectives	Louis Klotz Marilyn MacCabe Katharyn Ross
2:45-3:05	**A Historical Look at Earthquakes in the Northeast**	Walter Mitronovas Gary Nottis
3:05-3:35	**The Boston Loss Analysis Study** (A scenario study of a future, projected earthquake)	John Ebel
3:35-3:55	**Structural Environment of Schools**	Louis Klotz
3:55-4:15	**Nonstructural Safety in Schools**	Virginia Kimball
4:15-4:30	**Break**	
4:30-4:45	**Regional Safety/Emergency Response - Earthquake Safety of New England Schools**	Daniel Catlett
4:45-5:30	**A Prototypical Earthquake Drill - A Critical Skills Exercise**	Sean Cox
5:30-6:30	**Poster Sessions and Resource Displays: Seismic Networks, QUAKELINE, Earthquake Education Materials, Experiments, Nonstructural Hazard Mitigation Plans, FEMA publications and Cash Bar** - *Great Bay Foyer*	
6:30-7:30	**Dinner**	
7:30-8:30	**Hands-on, Minds-on Earthquake Education: Curricular Options and Shaky Activities** - *Great Bay Room*	Katharyn Ross

AGENDA - DAY TWO - Saturday, September 26, 1992
IMPLEMENTATION

8:30-10:00 AM	**CONCURRENT PANEL DISCUSSIONS** (The 3 "E's" of Earthquake Education) **(1) Education - Curricular Options**: - *Kennebec Room* (a) Integrating Earthquake Education into the Classroom - Tori Zobel (b) Misconceptions in the Options Available to Earthquake Educators - Jeffrey Callister (c) Hands-on Earthquake Education Workshop at the New York State Museum - Gary Nottis (d) The Center for the Earth Sciences and How it can Facilitate Earthquake Education - Mark Shoengold **(2) Environment/Structure:** - *Great Bay Room A* (a) Physical Results of Earthquakes and Their Effect on the Built Environment - Andrea Dargush (b) The Geologic Effect on Earthquake Ground Motions - John Ebel (c) Massena Center, NY Earthquake of 1944 and Its Effect on Area Schools - Walter Mitronovas (d) Making the Structural Environment of Schools Safer - Louis Klotz **(3) Emergency Preparedness--More Than "Duck, Cover, Hold":** - *Great Bay Room B* (a) Earthquake Preparedness: A High School Perspective - Virginia Kimball (b) Coordinating Earthquake Preparedness Efforts with the State Education Department - An Example from Arkansas - Daniel Cicirello (c) School Emergency Preparedness in New York State - John DiNuzzo (d) Earthquake Preparedness in New England Schools - What's Happened? What's Next? - Daniel Catlett
10:00-10:15	**Break**
10:15-11:45	**Discussion Groups** - participants remain in their groups to discuss specific questions. Questions such as the following will be discussed: **(1) Education** - *Kennebec Room* Discussion Facilitator - Katharyn Ross Recorder - Mark Worobetz

AGENDA - DAY TWO - Saturday, September 26, 1992
IMPLEMENTATION (Cont'd)

(a) What is the earthquake threat in each state (and/or region) of the Northeast and the perception of the present capability in the schools to respond to it?
(b) What steps or activities can individuals take to increase earthquake awareness and concern in school settings?
(c) How can earthquake education be integrated into the existing curriculum? What are additional curricular opportunities?
(d) How can earthquake education help achieve science objectives?

(2) Environment/Structure - *Great Bay Room A*
Discussion Facilitator - Andrea Dargush
Recorder - Bruce Berman
(a) How can individuals take an active role in non-structural hazard mitigation in the schools?
(b) How can individuals take a more pro-active role in the enactment of seismic building codes?
(c) Should the state mandate seismic provisions in building codes? Should it be just for critical facilities? All facilities?
(d) What liability does/or should the school have if seismic hazard mitigation is not implemented and a damaging earthquake occurs?
(e) How much regulation should be enforced for existing structures?

(3) Emergency Preparedness - *Great Bay Room B*
Discussion Facilitator - Marilyn MacCabe
Recorder - Alan Goldstein
(a) What is the earthquake threat in each state (and/or region) of the Northeast and the perception of Emergency Preparedness organizations to respond to it?
(b) What steps or activities can individuals take to increase emergency preparedness in school settings?
(c) Should school disaster plans be coordinated with local emergency management organizations?
(d) Should there be mandatory state guidelines for earthquake preparedness in the schools?
(e) How can schools develop and implement a disaster plan for earthquakes?

AGENDA - DAY TWO - Saturday, September 26, 1992
IMPLEMENTATION (Cont'd)

11:45-12:30 PM	**Poster Sessions and Resource Displays**	
12:30-1:15	**Lunch**	
1:15-2:00 PM	**Lunch Speaker - Ms. Lydia Walker, Director, Cooperative Disaster Child Care - Planning as Though Children Mattered: Earthquake Preparedness for the Sake of Children's Security and Stability as well as Physical Safety** - *Great Bay Room*	
2:00-3:00	**Reports from Discussion Groups**	Bruce Berman Alan Goldstein Mark Worobetz
3:00-3:15	**An Overview of Earthquake Resources for Schools**	Marilyn MacCabe
3:15-3:30	**Where do we go from here? - The Next Step**	Daniel Catlett Marilyn MacCabe Katharyn Ross
3:30	**Adjourn**	

NORTHEASTERN EARTHQUAKE EDUCATION WORKSHOP
Durham, NH
September 25-26, 1992

EVALUATION SUMMARY

Part I

Directions: Please rate your agreement with the following statements using a scale of 1-5.

	Strongly Disagree 1	2	3	4	Strongly Agree 5
OVERALL WORKSHOP					
1. The workshop helped me gain a better understanding of earthquakes and their causes (18)*	0%	22%	22%	28%	28%
2. The workshop gave me more information about earthquake risk in the northeastern part of the United States (18)	0%	0%	17%	39%	44%
3. I learned several ways to reduce non-structural hazards in schools (18)	6%	0%	0%	33%	61%
4. I learned how to address the fears and anxieties that children have related to earthquakes (18)	0%	0%	28%	44%	28%
5. I learned how to plan for a crisis in my educational environment (18)	0%	6%	28%	55%	11%
6. I learned how to plan an earthquake drill in my educational environment (17)	6%	6%	29%	41%	18%
7. I learned "quake-safe" actions to take before, during, and after an earthquake (18)	0%	6%	6%	71%	17%
8. I learned ways to integrate science with safety in an earthquake unit (17)	6%	6%	24%	46%	18%
9. I learned educational principles that will enhance my presentation of earthquake information (18)	6%	11%	44%	28%	11%
10. I learned geologic information that I will incorporate in my earthquake presentations (17)	6%	12%	18%	52%	12%

*Indicates number of respondents for each question.

	Strongly Disagree 1	2	3	4	Strongly Agree 5
MATERIALS PROVIDED					
11. The materials I received will be beneficial to my educational program (18)	0%	0%	6%	28%	66%
12. Materials in the folders (Preliminary Proceedings) and at exhibit tables provided me with useful information (18)	0%	0%	0%	28%	72%
DISCUSSION GROUPS:					
13. I found it helpful to discuss issues related to earthquake education (18)	0%	6%	11%	39%	44%
14. The discussion group gave me a better understanding of the issues involved in earthquake education (18)	0%	6%	6%	33%	55%
15. The discussion groups gave me strategies to implement earthquake education in the school system (18)	0%	11%	11%	45%	33%
16. Prior to this conference, I was aware of earthquake education and the need for its inclusion in the schools (17)	12%	12%	35%	6%	35%
17. Prior to this conference, I was concerned about earthquake education and its inclusion in the schools (17)	18%	12%	18%	24%	28%
18. I now rate my awareness as (17)	0%	0%	6%	18%	76%
19. I now rate my concern as (17)	0%	6%	0%	24%	70%
20. Future workshops should be planned to continue the work initiated at this meeting (17)	0%	0%	0%	24%	76%

Part II

Directions: Please provide feedback to the following questions:

1. What other materials should have been included in the folders or during sessions?

- diagrammatic seismic information
- photos
- slides
- maps showing epicenters and intensities
- materials and contents for older (12-18 year old) students
- actual scientific information on the mechanics of earthquakes
- materials on other disasters - hazardous materials, floods, hurricanes
- slide set with script
- bibliography of earthquake materials and resources
- copy of poster with desks holding up concrete (Mexico City earthquake)
- a primer on current scientific knowledge about earthquakes

2. What workshop component(s) did you find particularly useful?

- group discussion
- structural education
- non-structural damage prevention
- engineering information
- legal information
- new information and insights
- concurrent sessions
- excellent program director
- mitigation strategies
- FEMA materials
- earthquake preparedness
- excellent samples and bibliography
- being in an informal setting with experts in fields of engineering/seismology
- information on the threat in the northeast and ways to mitigate any damage
- environment/structure group
- geologic information
- critical skills exercise
- curricular options
- poster sessions, resource displays
- good variety of speakers

3. What are your suggestions for improving the workshop?

- more information on the workings behind an earthquake
- frustration from not being able to attend concurrent workshops
- involve primary grade teachers
- more specific information on how to do a project like Sean Cox did (Prototypical Earthquake Drill)
- Generic presentation on Executive Order 12699
- Don't assume all participants are thoroughly familiar with the science of earthquakes
- Invite police and fire department, Red Cross, school social workers, crisis team members for their perspective
- Briefer reports from discussion groups <u>or</u> have summaries available as handouts
- Need participation by educational administrators, school board directors, other state/local officials
- Focus should include other disasters
- Time to share what's going on in schools - it's helpful to find out what works
- Development of hands-on activities to take back to classroom
- More geologic information
- Gear speakers more to the audience
- Be cognizant of gender issues that may impact on the topic; use non-sexist language
- Show film of actual earthquake
- Need a more rigorous mental health dimension
- Stress more the substantive scientific basis linked to the preparedness

NATIONAL CENTER FOR EARTHQUAKE ENGINEERING RESEARCH
LIST OF TECHNICAL REPORTS

The National Center for Earthquake Engineering Research (NCEER) publishes technical reports on a variety of subjects related to earthquake engineering written by authors funded through NCEER. These reports are available from both NCEER's Publications Department and the National Technical Information Service (NTIS). Requests for reports should be directed to the Publications Department, National Center for Earthquake Engineering Research, State University of New York at Buffalo, Red Jacket Quadrangle, Buffalo, New York 14261. Reports can also be requested through NTIS, 5285 Port Royal Road, Springfield, Virginia 22161. NTIS accession numbers are shown in parenthesis, if available.

NCEER-87-0001 "First-Year Program in Research, Education and Technology Transfer," 3/5/87, (PB88-134275/AS).

NCEER-87-0002 "Experimental Evaluation of Instantaneous Optimal Algorithms for Structural Control," by R.C. Lin, T.T. Soong and A.M. Reinhorn, 4/20/87, (PB88-134341/AS).

NCEER-87-0003 "Experimentation Using the Earthquake Simulation Facilities at University at Buffalo," by A.M. Reinhorn and R.L. Ketter, to be published.

NCEER-87-0004 "The System Characteristics and Performance of a Shaking Table," by J.S. Hwang, K.C. Chang and G.C. Lee, 6/1/87, (PB88-134259/AS). This report is available only through NTIS (see address given above).

NCEER-87-0005 "A Finite Element Formulation for Nonlinear Viscoplastic Material Using a Q Model," by O. Gyebi and G. Dasgupta, 11/2/87, (PB88-213764/AS).

NCEER-87-0006 "Symbolic Manipulation Program (SMP) - Algebraic Codes for Two and Three Dimensional Finite Element Formulations," by X. Lee and G. Dasgupta, 11/9/87, (PB88-218522/AS).

NCEER-87-0007 "Instantaneous Optimal Control Laws for Tall Buildings Under Seismic Excitations," by J.N. Yang, A. Akbarpour and P. Ghaemmaghami, 6/10/87, (PB88-134333/AS).

NCEER-87-0008 "IDARC: Inelastic Damage Analysis of Reinforced Concrete Frame - Shear-Wall Structures," by Y.J. Park, A.M. Reinhorn and S.K. Kunnath, 7/20/87, (PB88-134325/AS).

NCEER-87-0009 "Liquefaction Potential for New York State: A Preliminary Report on Sites in Manhattan and Buffalo," by M. Budhu, V. Vijayakumar, R.F. Giese and L. Baumgras, 8/31/87, (PB88-163704/AS). This report is available only through NTIS (see address given above).

NCEER-87-0010 "Vertical and Torsional Vibration of Foundations in Inhomogeneous Media," by A.S. Veletsos and K.W. Dotson, 6/1/87, (PB88-134291/AS).

NCEER-87-0011 "Seismic Probabilistic Risk Assessment and Seismic Margins Studies for Nuclear Power Plants," by Howard H.M. Hwang, 6/15/87, (PB88-134267/AS).

NCEER-87-0012 "Parametric Studies of Frequency Response of Secondary Systems Under Ground-Acceleration Excitations," by Y. Yong and Y.K. Lin, 6/10/87, (PB88-134309/AS).

NCEER-87-0013 "Frequency Response of Secondary Systems Under Seismic Excitation," by J.A. HoLung, J. Cai and Y.K. Lin, 7/31/87, (PB88-134317/AS).

NCEER-87-0014 "Modelling Earthquake Ground Motions in Seismically Active Regions Using Parametric Time Series Methods," by G.W. Ellis and A.S. Cakmak, 8/25/87, (PB88-134283/AS).

NCEER-87-0015 "Detection and Assessment of Seismic Structural Damage," by E. DiPasquale and A.S. Cakmak, 8/25/87, (PB88-163712/AS).

NCEER-87-0016 "Pipeline Experiment at Parkfield, California," by J. Isenberg and E. Richardson, 9/15/87, (PB88-163720/AS). This report is available only through NTIS (see address given above).

NCEER-87-0017 "Digital Simulation of Seismic Ground Motion," by M. Shinozuka, G. Deodatis and T. Harada, 8/31/87, (PB88-155197/AS). This report is available only through NTIS (see address given above).

NCEER-87-0018 "Practical Considerations for Structural Control: System Uncertainty, System Time Delay and Truncation of Small Control Forces," J.N. Yang and A. Akbarpour, 8/10/87, (PB88-163738/AS).

NCEER-87-0019 "Modal Analysis of Nonclassically Damped Structural Systems Using Canonical Transformation," by J.N. Yang, S. Sarkani and F.X. Long, 9/27/87, (PB88-187851/AS).

NCEER-87-0020 "A Nonstationary Solution in Random Vibration Theory," by J.R. Red-Horse and P.D. Spanos, 11/3/87, (PB88-163746/AS).

NCEER-87-0021 "Horizontal Impedances for Radially Inhomogeneous Viscoelastic Soil Layers," by A.S. Veletsos and K.W. Dotson, 10/15/87, (PB88-150859/AS).

NCEER-87-0022 "Seismic Damage Assessment of Reinforced Concrete Members," by Y.S. Chung, C. Meyer and M. Shinozuka, 10/9/87, (PB88-150867/AS). This report is available only through NTIS (see address given above).

NCEER-87-0023 "Active Structural Control in Civil Engineering," by T.T. Soong, 11/11/87, (PB88-187778/AS).

NCEER-87-0024 "Vertical and Torsional Impedances for Radially Inhomogeneous Viscoelastic Soil Layers," by K.W. Dotson and A.S. Veletsos, 12/87, (PB88-187786/AS).

NCEER-87-0025 "Proceedings from the Symposium on Seismic Hazards, Ground Motions, Soil-Liquefaction and Engineering Practice in Eastern North America," October 20-22, 1987, edited by K.H. Jacob, 12/87, (PB88-188115/AS).

NCEER-87-0026 "Report on the Whittier-Narrows, California, Earthquake of October 1, 1987," by J. Pantelic and A. Reinhorn, 11/87, (PB88-187752/AS). This report is available only through NTIS (see address given above).

NCEER-87-0027 "Design of a Modular Program for Transient Nonlinear Analysis of Large 3-D Building Structures," by S. Srivastav and J.F. Abel, 12/30/87, (PB88-187950/AS).

NCEER-87-0028 "Second-Year Program in Research, Education and Technology Transfer," 3/8/88, (PB88-219480/AS).

NCEER-88-0001 "Workshop on Seismic Computer Analysis and Design of Buildings With Interactive Graphics," by W. McGuire, J.F. Abel and C.H. Conley, 1/18/88, (PB88-187760/AS).

NCEER-88-0002 "Optimal Control of Nonlinear Flexible Structures," by J.N. Yang, F.X. Long and D. Wong, 1/22/88, (PB88-213772/AS).

NCEER-88-0003 "Substructuring Techniques in the Time Domain for Primary-Secondary Structural Systems," by G.D. Manolis and G. Juhn, 2/10/88, (PB88-213780/AS).

NCEER-88-0004 "Iterative Seismic Analysis of Primary-Secondary Systems," by A. Singhal, L.D. Lutes and P.D. Spanos, 2/23/88, (PB88-213798/AS).

NCEER-88-0005 "Stochastic Finite Element Expansion for Random Media," by P.D. Spanos and R. Ghanem, 3/14/88, (PB88-213806/AS).

NCEER-88-0006 "Combining Structural Optimization and Structural Control," by F.Y. Cheng and C.P. Pantelides, 1/10/88, (PB88-213814/AS).

NCEER-88-0007 "Seismic Performance Assessment of Code-Designed Structures," by H.H-M. Hwang, J-W. Jaw and H-J. Shau, 3/20/88, (PB88-219423/AS).

NCEER-88-0008 "Reliability Analysis of Code-Designed Structures Under Natural Hazards," by H.H-M. Hwang, H. Ushiba and M. Shinozuka, 2/29/88, (PB88-229471/AS).

NCEER-88-0009 "Seismic Fragility Analysis of Shear Wall Structures," by J-W Jaw and H.H-M. Hwang, 4/30/88, (PB89-102867/AS).

NCEER-88-0010 "Base Isolation of a Multi-Story Building Under a Harmonic Ground Motion - A Comparison of Performances of Various Systems," by F-G Fan, G. Ahmadi and I.G. Tadjbakhsh, 5/18/88, (PB89-122238/AS).

NCEER-88-0011 "Seismic Floor Response Spectra for a Combined System by Green's Functions," by F.M. Lavelle, L.A. Bergman and P.D. Spanos, 5/1/88, (PB89-102875/AS).

NCEER-88-0012 "A New Solution Technique for Randomly Excited Hysteretic Structures," by G.Q. Cai and Y.K. Lin, 5/16/88, (PB89-102883/AS).

NCEER-88-0013 "A Study of Radiation Damping and Soil-Structure Interaction Effects in the Centrifuge," by K. Weissman, supervised by J.H. Prevost, 5/24/88, (PB89-144703/AS).

NCEER-88-0014 "Parameter Identification and Implementation of a Kinematic Plasticity Model for Frictional Soils," by J.H. Prevost and D.V. Griffiths, to be published.

NCEER-88-0015 "Two- and Three- Dimensional Dynamic Finite Element Analyses of the Long Valley Dam," by D.V. Griffiths and J.H. Prevost, 6/17/88, (PB89-144711/AS).

NCEER-88-0016 "Damage Assessment of Reinforced Concrete Structures in Eastern United States," by A.M. Reinhorn, M.J. Seidel, S.K. Kunnath and Y.J. Park, 6/15/88, (PB89-122220/AS).

NCEER-88-0017 "Dynamic Compliance of Vertically Loaded Strip Foundations in Multilayered Viscoelastic Soils," by S. Ahmad and A.S.M. Israil, 6/17/88, (PB89-102891/AS).

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