WHAT DO THOSE TECHNICAL TERMS MEAN?

INTRODUCTION

An important aspect of dealing with community seismic safety involves making sure that everyone "speaks the same language." If the community at large is to gain any real understanding of complex seismic issues, all of the persons involved in seismic safety activities need to understand and use the commonly accepted definitions for important terms.

GENERAL TERMS

The following definitions are from a 1984 U. S. Geological Survey Open-File Report (84-762), A Workshop on "Earthquake Hazards in the Virgin Islands Region", (Reston, Virginia: USGS):

Acceptable Risk - a probability of social or economic consequences due to earthquakes that is low enough (for example in comparison with other natural or manmade risks) to be judged by appropriate authorities to represent a realistic basis for determining design requirements for engineered structures, or for taking certain social or economic actions.

Damage - any economic loss or destruction caused by earthquakes.

Design Earthquake - a specification of the seismic ground motion at a site; used for the earthquake-resistant design of a structure.

Design Event, Design Seismic Event - a specification of one or more earthquake source parameters, and of the location of energy release with respect to the site of interest; used for the earthquake-resistant design of a structure.

Earthquake - a sudden motion or vibration in the earth caused by the abrupt release of energy in the earth's lithosphere. The wave motion may range from violent at some locations to imperceptible at others.

Elements at Risk - population, properties, economic activities, including public services etc., at risk in a given area.

Exceedence Probability - the probability that a specified level of ground motion or specified social or economic consequences of earthquakes, will be exceeded at the site or in a region during a specified exposure time.

Exposure - the potential economic loss to all or certain subset of structures as a result of one or more earthquakes in an area. This term usually refers to the insured value of structures carried by one or more insurers. See "Value at Risk."

Intensity - a qualitative or quantitative measure of the severity of seismic ground motion at a specific site (e.g., Modified Mercalli intensity, Rossi-Forel intensity, Housner Spectral intensity, Arias intensity, peak acceleration, etc.).

Loss - any adverse economic or social consequence caused by one or more earthquakes.

Seismic Event - the abrupt release of energy in the earth's lithosphere, causing an earthquake.

Seismic Hazard - any physical phenomenon (e.g., ground shaking, ground failure) associated with an earthquake that may produce adverse effects on human activities.

Seismic Risk - the probability that social or economic consequences of earthquakes will equal or exceed specified values at a site, at several sites, or in an area, during a specified exposure time.

Seismic Zone - a generally large area within which seismic-design requirements for structures are constant.

Value at Risk - the potential economic loss (whether insured or not) to all or certain subset of structures as a result of one or more earthquakes in an area. See "Exposure."

Vulnerability - the degree of loss to a given element at risk, or set of such elements, resulting from an earthquake of a given magnitude or intensity, which is usually expressed on a scale from 0 (no damage) to 10 (total loss).

The following excerpt from the 1983 National Research Council report, Multiple Hazard Mitigation (Washington, D.C.: National Academy Press), defines several other terms that sometimes cause confusion in discussions of seismic safety:

> ... The level of intensity or severity that is capable of causing damage depends upon the vulnerability of the exposed community; vulnerability is generally a function of the way in which structures are designed, built, and protected, and the vulnerability of a structure or community to a particular natural event is a measure of the damage likely to be sustained should the event occur. The degree to which a community is prone to a particular natural hazard depends on risk, exposure, and vulnerability. When a natural hazard occurrence significantly exceeds the community's capacity to cope with it, or causes a large number of deaths and injuries or significant economic loss, it is called a disaster.

Hazard management includes the full range of organized actions undertaken by public and private organizations in anticipation of and in response to hazards. Hazard management has two primary (but not completely distinct) components: emergency management. typified by the police, fire, rescue, and welfare work carried on during a disaster; the advance planning and training that are necessary if emergency operations are to be carried out successfully; and the post-disaster recovery period in which damage is repaired; and mitigation, which focuses on planning, engineering design, economic measures, education. and information dissemination, all carried out for the purpose of reducing the long-term losses associated with a particular hazard or set of hazards in a particular location.

MEASURES OF EARTHQUAKE MAGNITUDE AND INTENSITY

The following excerpt from the 1976 thesis, Seismic Design of a High-Rise Building, prepared by Jonathan Barnett and John Canatsoulis in partial fulfillment of the requirements for the degree of Master of Science at the Worcester Polytechnic Institute explains the Richter magnitude scale and the modified Mercalli intensity scale:

> There are two important earthquake parameters of interest to the structural engineer. They are an earthquake's magnitude and its intensity. The intensity is the apparent effect of an earthquake as experienced at a specific location. The magnitude is the amount of energy released by the earthquake.
>
> The magnitude is the easiest of these two parameters to measure, as, unlike the intensity which can vary with location, the magnitude of a particular earthquake is a constant. The most widely used scale to measure magnitude is the Richter magnitude scale. Using this scale, the magnitude, measured in ergs, can be found from the equation $\text{Log } E = 11.4 + 1.5 M$, where M is the Richter magnitude. This relationship was arrived at by an analysis of the amplitude of the traces of a standard seismograph located 100 kilometers from the epicenter of an earthquake and correlating this information with the radiated energy as determined through measurements of the waves released by the earthquake. The epicenter of an earthquake is the point on the surface of the earth directly over the focus. The focus (or hypocenter) is the point in the earth's crust at which the initial rupture (slippage of masses of rock over a fault) occurs. In use, the Richter scale represents an increase by a factor of 31.6 for each unit increase in the Richter magnitude. Thus, a Richter magnitude of 6 is 31.6 times larger than Richter magnitude 5....
>
> [A] problem with using the Richter magnitude is that it gives little indication of an earthquake's intensity. Two earth-

quakes of identical Richter magnitude may have widely different maximum intensities. Thus, even though an earthquake may have only one magnitude, it will have many different intensities.

In the United States, intensity is measured according to the modified Mercalli index (MMI). In Europe, the most common intensity scale is the Rossi-Forel scale while in Russia a modification of the Mercalli scale is used.

The following excerpt from Bruce A. Bolt's 1978 book, Earthquake: A Primer (San Francisco, California: W.H. Freeman and Company), describes the modified Mercalli intensity values (1956 version); masonry definitions from C. F. Richter's 1958 book, Elementary Seismology (San Francisco, California: W. H. Freeman Company), are inserted in brackets:

I. Not felt. Marginal and long-period effects of large earthquakes.

II. Felt by persons at rest, on upper floors, or favorably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frames creak.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knicknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D [weak materials such as adobe, poor mortar, low standards of workmanship; weak horizontally] cracked. Small bells ring (church and school). Trees, bushes shaken visibly, or heard to rustle.

VII. Difficult to stand. Noticed by drivers. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices also unbraced parapets and architectural ornaments. Some cracks in masonry C [ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners but not reinforced or designed against horizontal forces]. Waves on ponds, water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII. Steering of cars affected. Damage to masonry C; partial collapse. Some damage to masonry B [good workmanship and mortar; reinforced but not designed in detail to resist lateral forces]; none to masonry A [good workmanship, mortar, and design; reinforced, especially laterally; bound together by using steel, concrete, etc.; designed to resist lateral forces]. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX. General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. General damage to foundations. Frame structures, if not bolted down, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in the ground. In alluviated areas, sand and mud ejected, earthquake fountains and sand craters.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI. Rails bent greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown in the air.

EARTHQUAKE OCCURRENCES

The location of notable historic U.S. earthquakes is shown in Figure 2, which is reproduced from Mary L. Schnell and Darrell G. Herd's 1984 report, National Earthquake Hazards Reduction Program: Overview (FY 1983), Report to Congress, USGS Circular 918 (Reston, Virginia: U.S. Geological Survey).

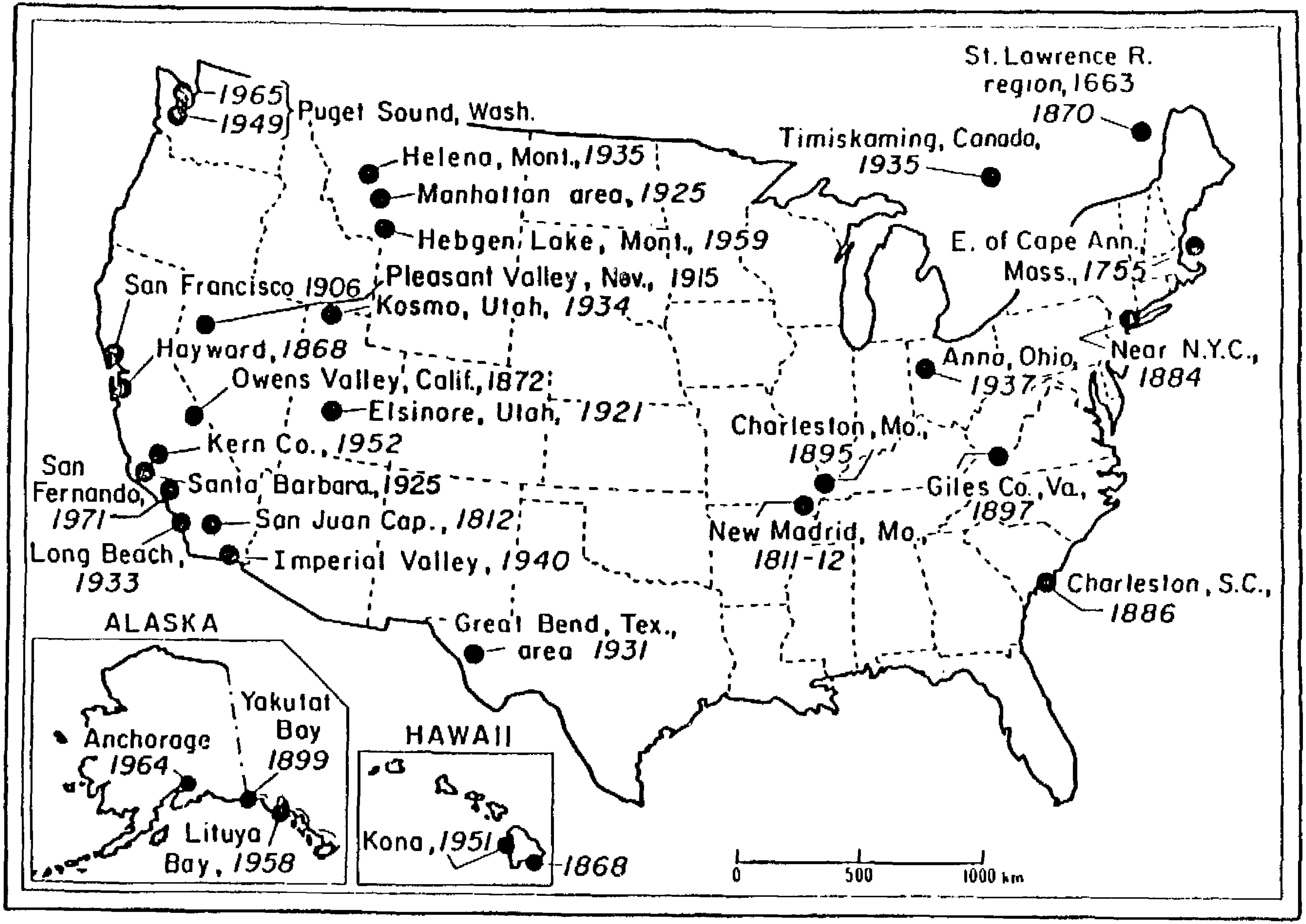

FIGURE 2 Notable damaging historic earthquakes in the United States. (Reproduced from Mary L. Schnell and Darrell G. Herd's 1984 report, National Earthquake Hazards Reduction Program: Overview (FY 1983), Report to Congress, USGS Circular 918, U.S. Geological Survey, Reston, Virginia.)

SOCIETAL IMPLICATIONS FEEDBACK SHEET

PLEASE RETURN THIS SHEET TO THE:
BUILDING SEISMIC SAFETY COUNCIL
1015 15th STREET, SUITE 700
WASHINGTON, D.C. 20005

- PLEASE DESCRIBE YOUR COMMUNITY'S EXPERIENCE WITH RESPECT TO NEW OR IMPROVED SEISMIC DESIGN PROVISIONS. FOR EXAMPLE:

  Who are the key decision-makers most reluctant to incorporate needed new or improved seismic safety provisions in building regulations?

  What appear to be the bases for such reluctance?

  What approaches have been used (or could be used) to overcome this reluctance and what degree of success has been achieved?

  Who seem to be the major proponents, and what appear to be their motivations?

- HAVE YOU FOUND THIS HANDBOOK INFORMATION USEFUL? IF SO, HOW HAS IT HELPED YOU, THE READER, SPECIFICALLY?

- HAVE YOU FOUND THIS HANDBOOK INFORMATION USELESS? IF SO, WHY?

(WE WOULD WELCOME YOUR FRANK OPINION, BUT ASK THAT REASONS BE PROVIDED SO THAT ANY FUTURE VERSIONS CAN BE MODIFIED APPROPRIATELY.)

- BASED ON YOUR COMMUNITY'S EXPERIENCE, WHAT ADDITIONAL TOPICS WOULD YOU LIKE TO SEE THIS HANDBOOK ADDRESS?

- WHAT OTHER KINDS OF INFORMATION OR HANDBOOKS WOULD YOU FIND PARTICULARLY USEFUL WITH RESPECT TO ENCOURAGING YOUR COMMUNITY TO UTILIZE NEW OR IMPROVED SEISMIC SAFETY PROVISIONS?

- WOULD YOU BE INTERESTED IN KNOWING OF THE AVAILABILITY OF OTHER BSSC REPORTS?

- ANY ADDITIONAL COMMENTS YOU WOULD LIKE TO OFFER WOULD BE APPRECIATED.

NAME: ______________________________

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BUILDING SEISMIC SAFETY COUNCIL

AFL-CIO Building and Construction Trades Department
American Concrete Institute
American Consulting Engineers Council
American Council of Independent Laboratories, Inc.
American Institute of Architects
American Institute of Steel Construction
American Insurance Association
American Iron and Steel Institute
American Plywood Association
American Society of Civil Engineers
Applied Technology Council
Associated General Contractors of America
Association of Engineering Geologists
Association of Major City Building Officials
Association of the Wall and Ceiling Industries, International
Brick Institute of America
Building Officials and Code Administrators, International
Building Owners and Managers Association, International
California Dynamics Corporation
Canadian National Committee on Earthquake Engineering
Concrete Masonry Association of California and Nevada
Concrete Reinforcing Steel Institute
Contract Services Administration Trust Fund
Council of American Building Officials
Earthquake Engineering Research Institute
Interagency Committee on Seismic Safety in Construction
International Conference of Building Officials
Masonry Institute of America
Masonry Institute of Washington
Metal Building Manufacturers Association
National Association of Home Builders
National Association of Housing and Redevelopment Officials
National Fire Sprinkler Association
National Concrete Masonry Association
National Elevator Industry, Inc.
National Forest Products Association
National Institute of Building Sciences
Oklahoma Masonry Institute
Portland Cement Association
Prestressed Concrete Institute
Rack Manufacturers Institute
Soil and Foundation Engineers Association
Socotec, U.S.A. Corporation
Southern Building Code Congress International
Steel Plate Fabricators Association, Inc.
Structural Engineers Association of Arizona
Structural Engineers Association of California
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