Unit 7

Conclusions

COURSE REVIEW

The purpose of Executive Order 12699 is to prepare the nation to better withstand the force of an earthquake. The Order accomplishes this goal by requiring minimum standards for the seismic safety of federally owned, assisted, or regulated new buildings—standards which, once implemented, can reduce the risk of injury, loss of life, and devastation to buildings and other structures. This requirement is expected to compel jurisdictions to adopt building codes with appropriate seismic components.

HISTORY OF EARTHQUAKES IN THE UNITED STATES

In Unit 1, we learned that major earthquakes have occurred in such disparate locations as New Mexico, South Carolina, Missouri, Utah, and Massachusetts. This means that States well known for earthquake activity are not the only ones experiencing significant levels of seismic hazard. Furthermore, increased population and construction in these and other areas mean that an earthquake of a force similar to that of earthquakes in the past would present much greater risk to human life and property today.

Although the region in which you live may not have experienced seismic activity in the recent past, your community must not ignore the need to take steps to reduce the risk of damage from seismic activity. Post-disaster studies have shown that community investment in mitigation efforts like the adoption of building codes, zoning regulations, and land-use practices pay direct dividends.

Executive Order 12699

Unit 2 presented the history and intent of Executive Order 12699. The first piece of Federal

earthquake hazard mitigation legislation enacted by Congress was the Earthquake Hazards Reduction Act of 1977, which established the National Earthquake Hazards Reduction Program (NEHRP). NEHRP was created to focus on:

- Design and construction methods for earthquake resistant structures;
- Earthquake prediction;
- Model building codes;
- Education of the public, State and local officials, and private industry; and
- Research in earthquake hazard mitigation and earthquake insurance.

Recommended Provisions for the Development of Seismic Regulations for New Buildings, a report produced by NEHRP, presents a national approach to seismic design. In 1980, the Interagency Committee on Seismic Safety in Construction (ICSSC) began to encourage Federal agencies to adopt the provisions set forth by NEHRP. Toward this end, ICSSC drafted Executive Order 12699.

In its final form, Executive Order 12699 contains procedures and regulations for ensuring the structural safety of newly constructed buildings and new additions to buildings that are Federally owned, purchased or constructed with Federal assistance, or leased for Federal use. The Order also applies to Federally assisted reconstruction of buildings following disasters. The minimum standards set forth in Executive Order 12699 are the standards and practices of NEHRP.

Anyone involved in new construction that is subject to the Order must know and use the seismic provisions in your community's building code. These individuals include State and local decisionmakers, architects, lenders, zoning and land-use officials, engineers and construction personnel, and building code officials.

Causes of Earthquakes

In Unit 3 of this course, we discussed the causes and characteristics of earthquakes. Widely accepted plate tectonics theory holds that the earth once was covered by a single crust, or plate and that over time this plate split and drifted into separate plates of land masses and oceans. Any movement of these plates—whether toward, away, or past one another—can cause an earthquake. Maps of earthquakes throughout the world show that earthquakes most frequently occur at the boundaries of plates. Plate movement can create tremendous stress on rock, causing it to fracture so that the rock mass on either side of the fracture moves. This fracture is called a fault. If there is a sudden rupture and movement of rock along a fault line, an earthquake will result.

The shaking we experience during an earthquake is caused by seismic waves moving from the center of the earthquake out to other parts of the earth. There are two main categories of seismic waves:

- *Body waves* travel through the earth *below* and *on* the surface. Scientists use body waves to find the epicenter of an earthquake.

- *Surface waves* travel on the surface only and cause the greatest amount of damage.

Within these categories there are subcategories of seismic waves, which cause different types of damage. Because the composition of the soil and topography of an area will affect the intensity of seismic waves, you should consider these when developing your earthquake mitigation plan. Two scales frequently are used to measure earthquakes:

- The *Modified Mercalli Intensity Scale* measures the intensity or impact of an earthquake on people and the built environment.

- The *Richter Scale* measures the amount of energy released by an earthquake, or its magnitude.

Measures in addition to intensity and magnitude are needed to predict how an earthquake might affect structures in a community. Buildings constructed according to estimates of how fast, how

long, and how much the ground moves during an earthquake will sustain far less damage.

Seismic risk maps are another important tool for constructing seismically safe buildings. Designers use them to determine an area's relative level of seismic activity. The NEHRP *Provisions* and the three national model building codes include these maps.

Effects of Earthquakes

In Unit 4, we learned about the effects earthquakes can have on the natural and built environments. The vibrations of seismic waves produce several different effects on the natural environment, which in turn can cause tremendous additional damage to the built environment:

- Liquefaction,
- Landslides,
- Faults,
- Tsunamis, and
- Seiche.

Communities should give careful consideration to location before starting to build, particularly avoiding known faults or sites that are subject to or can be affected by a landslide.

Unit 4 also addressed the characteristics of buildings that affect performance during an earthquake and talked about how buildings can be designed to resist earthquake forces. Designers must determine how a building's period, configuration, story design, and propensity to drift and the rigidity or ductility of the materials with which it is built will affect the structure during an earthquake.

Period

The period, or rate at which a building sways back and forth, influences how a building will

react to an earthquake. If a seismic wave causes the ground to move with the same period as a building

on the ground, their vibrations are magnified, causing greater stress on the building. Buildings can be designed using partitions, ceilings, and exterior walls to dampen a building's vibration.

Ductility

Buildings made of ductile (flexible) materials such as steel are less likely to collapse during an earthquake than buildings made of concrete. Problems also can occur during an earthquake if a building is made of a combination of rigid and flexible materials. This happens because earthquake forces focus on the stiffer elements of a building and cause them to fail abruptly and shatter. To avoid this, buildings should be constructed of elements having the same level of flexibility.

Drift

Drift is the extent to which a building sways. We normally do not think of a building as swaying, but earthquake forces can cause it to do so. A high level of drift (bending or swaying) can cause a building to bump into the building next to it. Limits often are imposed on ductility so a building will not be *so* flexible that drift resulting from earthquakes does not cause one building to damage another.

Configuration

In general, a building with a symmetrical design and balanced resistance will best resist an earthquake. T-, H-, and L-shaped buildings will experience increased stress at the point where the wings of the building meet and incur damage during an earthquake. Symmetrical buildings with nonsymmetrical elements, such as ceilings and walls, also may incur major damage during an earthquake.

Soft-story

Buildings with stiff upper stories and open, flexible first stories also are likely to be damaged in

an earthquake. An example of this type of building is an office building in which the first floor is a parking garage.

Earthquake-Resistant Construction Methods

During an earthquake, a building is subjected to the horizontal forces created by ground motion, as well as the normal vertical forces of gravity. Three horizontal bracing systems can be used to resist earthquake forces:

- Shear wall systems,
- Braced frame systems, and
- Moment-resistant systems.

Sometimes it is advantageous to use a combination of a moment-resistant frame and a shear wall or braced frame, called a dual system. Seismic safety, cost, and architecture all play a part in a designer's choice of methods.

In addition to the risk of direct harm to people and the built environment, several secondary hazards from earthquakes exist. The secondary effects of earthquake-induced fires, hazardous material spills, and breakdowns in utility lifelines can cause extensive damage and loss of life. Taking steps to prepare your community before an earthquake strikes can save lives and prevent or reduce property damage from these effects.

Protecting Your Community

Unit 5 provided information on how you can ensure that earthquake mitigation planning is taking place in your community. Use of one of the major building codes is a tremendous help to a community's mitigation efforts.

A building code requires that a building or facility be located, designed, and constructed so that any threat to the life, health, and welfare of its occupants and the public is minimized or

prevented. The seismic provisions in the national model codes are substantially equivalent to the NEHRP *Provisions*. If your community adopts the most recent editions of one of these codes, including its seismic provisions, you will be utilizing the most advanced seismic provisions available.

The seismic forces created within a building during an earthquake depend on the nature of the ground motion, as well as the design and construction of the building. Builders use seismic hazard maps developed using historical seismicity, proximity to known faults, and geological information to determine a likely level of seismic risk for their communities. This information helps them to determine how to design and construct safe buildings economically.

In addition to the seismic hazard level in a particular location, mitigation planners also take into account the relative importance of some buildings and their occupancy rate over others in a specific community. Buildings like hospitals and police departments, which are needed particularly following an earthquake, or high-occupancy buildings like schools, hotels, and office buildings are built using higher standards for seismic protection than others. The NEHRP *Provisions* divide buildings into three Seismic Use Groups that are subject to different provisions.

The *Provisions* go one step further and combine the Seismic Use Group assigned to a building with the seismicity of the location of the building to put it in a Seismic Design Category. The six Seismic Design Categories defined in the *Provisions* provide communities with guidance on enforcing seismic safety standards for various buildings within their community.

Evaluating Your Community's Safety

Unit 6 of this course addressed evaluation of your community’s level of seismic safety.

The best way to protect your community and, at the same time, comply with Executive Order 12699 is to adopt a national model building code with its seismic provisions. Any version of a model building code adopted in its entirety will include seismic provisions that cover all the requirements listed in the Executive Order.

Figure 7-1 shows a summary of action steps your community will need to take to ensure

compliance with Executive Order 12699.

The model building code organizations make it easy to adopt a code by providing a sample ordinance and assistance during the adoption process. In those communities that have already adopted a model code, but an earlier version (not the latest version that contain seismic provisions), need only *update* their code to include the provisions. Each community should be sure to provide updating procedures within its building code administration steps.

No matter what the building code adoption process is in your community you will have to convince key decision-makers that adopting a building code with seismic provisions is the best step to take to secure the community's safety and compliance with the Executive Order. Being prepared with answers to likely questions and concerns is an important step in building public support for adopting or updating your community's building code.

COURSE SUMMARY

The purpose of the Executive Order 12699 is to reduce risk to the lives of occupants of buildings owned, leased, assisted, or regulated by the Federal Government and to persons who would be affected by the failures of Federal buildings in earthquakes; to improve the essential Federal buildings so they can function during or after an earthquake; and to reduce earthquake losses of public buildings and investments in a cost-effective manner. While it is clear that the Federal community must prepare procedures and regulations necessary to comply with Executive Order 12699, it is not as clear how this Order affects others.

Several units in this course provided you with background information on earthquakes and their effects. The most important point of this course is that earthquake effects can be lessened with the use of seismic components of building codes. The three model building codes used throughout the United States will protect a community by reducing its seismic risk and, at the same time, allow communities to comply with Executive Order 12699 so they can receive Federal funds and new Federal business.

Finally, a series of questions is provided to help evaluate your community for seismic safety and compliance with Executive Order 12699. The best and easiest way to protect your community, comply with Executive Order 12699, and continue to receive Federal funds, loans, and grants is

to adopt and enforce the seismic components of a model building code.

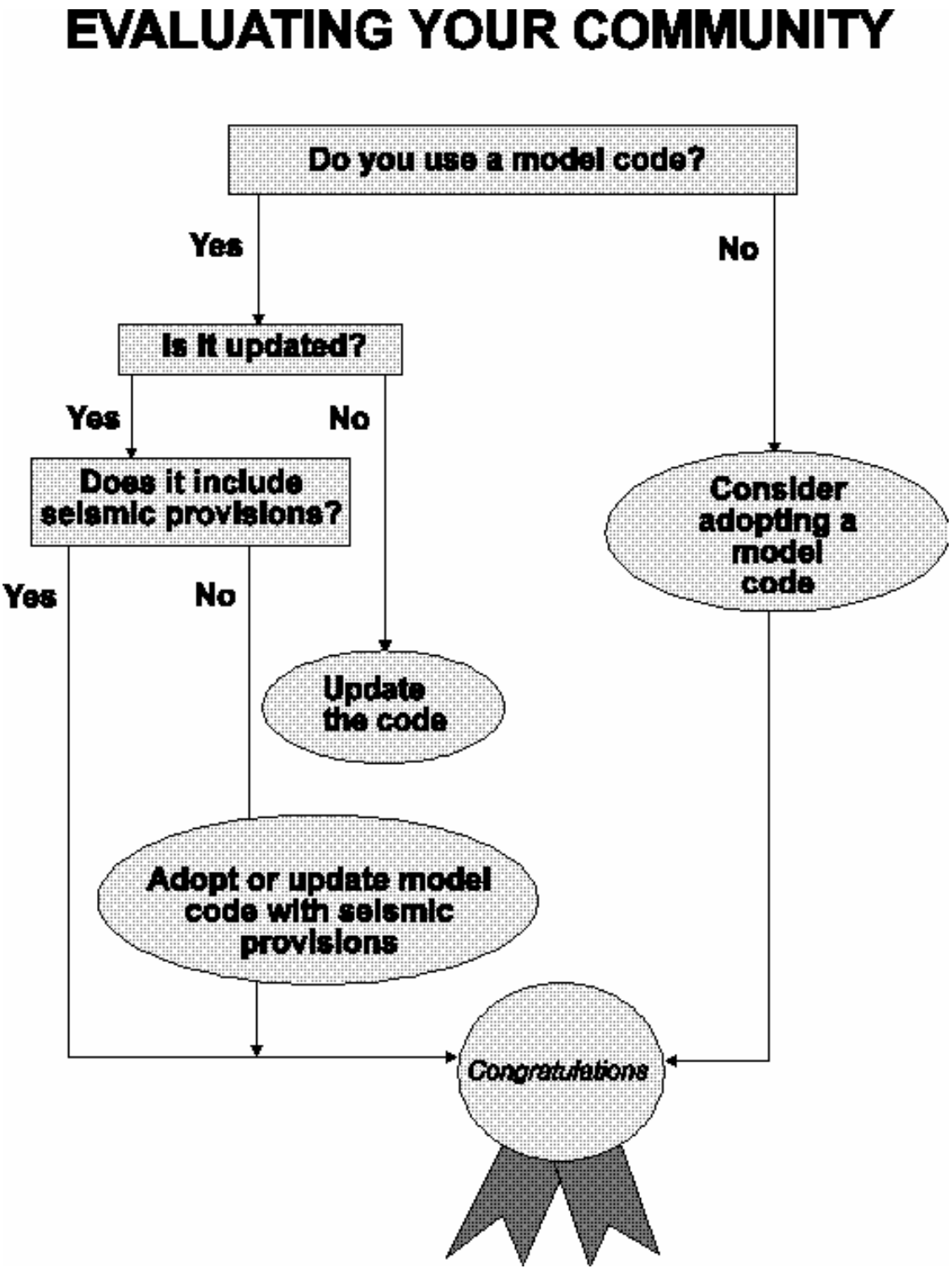
EVALUATING YOUR COMMUNITY
Do you use a model code?
Yes
No
Is it updated?
Yes
No
Does it include seismic provisions?
Yes
No
Consider adopting a model code
Update the code
Adopt or update model code with seismic provisions
Congratulations

Figure 7-1