

Earthquake Hazards

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Section

In this lab, you will: examine various earthquake hazards and some of the techniques that can help minimize the loss of life and property damage.

Background Reading and Needed Supplies

Before doing this exercise, you should read Chapter 4 in the textbook.

Concerning supplies, you will need a calculator, ruler, and colored pencils.

Each year, the vibrational (seismic) waves from earthquakes cause buildings to fail somewhere in the world, resulting in the death of large numbers of people. In addition to buildings, earthquakes cause considerable damage to human infrastructures, such as utility lines and transportation systems. Seismic waves also can trigger highly destructive tsunamis and landslides. Although humans cannot prevent earthquakes, we can use science and engineering to help minimize hazards. In this exercise, we will explore some of the earthquake hazards and ways we can reduce the loss of life and property damage.

1) The map in Figure 3.1 shows the location of earthquake epicenters that occurred over a 35-

Year period. Note how the epicenters clearly define the edge of Earth's tectonic plates.

- a) Using a red colored pencil, place a set of arrows at the plate boundaries listed below so as to indicate whether the boundary is dominated by compressional, tensional, or shearing Forces (i.e., indicate whether the edges are convergent, divergent, or transform.

the mid-ocean ridge in the Atlantic

the western coast of South America

the west coast of North America

Aleutian Islands of Alaska

Japan

Islands of Indonesia

Part I – Earthquakes and Plate Tectonics

- b) What is the name of the geologic process that takes place along the plate boundary running through the Atlantic basin?

Convergent plate boundaries. Collisions in the area cause volcanic activities and earthquakes

- c) What geologic process occurs along the convergent boundaries you identified on the Map? **Collision**

- d) What is the name of the earthquake hazard that can develop along convergent boundaries Which is capable of bringing death and destruction to distant shorelines?

Tsunamis

e) Explain why large magnitude earthquakes are relatively rare along divergent boundaries,

But quite common along convergent boundaries.

In divergent boundaries, a new crust is generated as the plates pull away from one another where the piling is not allowed which may cause the creation of volcanoes

Ex 3 – Earthquakes

Part II – Seismic Waves and Buildings

2) Figure 3.2 illustrates how earth materials vibrate differently in response to the passing of

Different types of seismic waves. Based on this illustration, explain why surface waves generally cause the most damage to human structures. Surface waves are seismic waves that are near the surface of the Earth, and the common ones are the Rayleigh and Love waves. Rayleigh waves are the most destructive since they move both vertically and horizontally. They can move vehicles up and down and a car park while love waves can cause horizontal shearing of the ground and damage the foundation of structures because they move from side to side in a horizontal plane.

Figure 3.2

3) Figure 3.3 is a simplified sketch showing the structural skeleton of a typical multi-story

Building. A supporting structure usually consists of steel or steel-reinforced concrete. Based

on what you learned in the textbook about seismic waves and buildings, indicate on the

sketch the three types of engineering features that could be added to help prevent this

edifice from collapsing in the event of an earthquake.

Figure 3.3

Ex 3 – Earthquakes

Isolation bearings

Short Strong column and weak beams

Steel bars and concrete walls

4) Seismic engineering controls in multi-story buildings are especially important should the Building experience, the phenomenon known as resonance, which causes it to shake more violently during an earthquake. Describe how resonance works and explain why it may occur in some multi-story buildings within a city and not others.

Resonance is a system trend to oscillate on high amplitude. Every building has a period of resonance, which takes several seconds for a building to vibrate back and forth. The ground also has a specific resonance frequency. The tall building will have low-frequency oscillations while a short building will respond to high-frequency oscillations.

5) As seismic waves travel outward from the focus through solid bedrock, they naturally lose Energy and become weaker. However, if the waves encounter unconsolidated sediment, such as in a sedimentary basin, they will begin to slow down and lose power at a faster rate. As illustrated in Figure 3.4, this more rapid transfer of control can lead to ground amplification where the ground itself shook more violently, thereby increasing the threat to buildings and

infrastructure.

Figure 3.4

a) The relief map on the following page shows the amount of ground amplification that can be

Expected to occur in the Los Angeles area. Using a black colored pencil, outline those areas

Where ground amplification is expected to occur (i.e., non-purplish areas where

augmentation is > 1).

b) Add labels to your map indicating what areas are underlain by bedrock and those

Underlain by sediment.

c) Explain as to why some parts of the sedimentary deposit are expected to

Experience as much as a five-fold increase in ground shaking (yellow color), whereas

, in other areas, the growth maybe by a factor of three or less (reddish tones). This is because of the oscillation frequency that differs n different amplitudes

d) Notice that the yellow area in the northwest portion of the map has a distinct shape.

Describe what this feature represents and explain why the ground amplification is expected to be so high there.

Since t s a river, the water s saturated and the energy transfer will cause amplifications

Ex 3 – Earthquakes

6) Explain why the areas in metro Los Angles with an increased risk of ground amplification also

Happen to be places where the population density is the highest. In other words, why did most

Of the development occur where the risk of earthquake damage is the greatest?

In California, a system of grading regulations was established and reduced 90% of landslides damages to parts affected. A high population and the increase of infrastructure add on the risk making hazard relief relevant.

7) Imagine that you are an executive with a large insurance company. Explain how a map of

Potential ground amplification might affect your company's rates for earthquake insurance.

The estimations of earthquakes loss on geographic places estimated by hazards U.S. methodology. When the size and location of hypothetical earthquakes are noticed, the software calculates the violence of ground vibration number of casualties, the number of displaced people, and the approximate repairing cost on damages and other effects.

8) Suppose you were to move to a city where the risk of a significant earthquake is relatively high,

but ground amplification maps are not available. Describe the types of geologic information that you could use instead, which might help you avoid moving into a high-risk area.

The occurrence of tsunamis and volcanic activates in an area since they occur in places where earthquakes are highly experienced.

Part III – Intraplate Earthquakes

Large earthquakes are most common along convergent and transform plate boundaries, but they can also take place along old, buried faults in the middle of tectonic plates. These so-called intraplate earthquakes are of great concern because they occur rather infrequently, which means

people are generally less prepared. We can get an idea of the risk of intraplate quakes in the U.S. by examining the USGS seismic hazard map shown in Figure 3.5. This map shows the strength of the horizontal ground motion (relative to gravity) that has a 10% chance of occurring over 50 years. For example, we can see that in the Los Angeles area, there is a 10% probability in the next 50 years of an earthquake with a lateral ground motion of more than 0.32 times the force of gravity.

Although the seismic hazard map in Figure 3.5 provides information as to the probability of different levels of ground shaking in a given area, it says nothing about the level of earthquake preparedness. Along the transform plate boundary in California, for example, significant earthquakes are relatively frequent. Consequently, state and local building codes in this region generally require seismic engineering controls that are designed to help structures withstand lateral ground shaking. Except for California, most of the high-risk areas in the United States have not experienced a significant earthquake in modern times; thus, they are far less prepared in terms of seismic engineering and emergency management planning.

Ex 3 – Earthquakes

9) Notice in Figure 3.5 how the area along the Mississippi River valley has a seismic-risk level

Similar to what is found along the plate boundary in California. In the winter of 1810-11, a series of magnitude eight quakes occurred in the Mississippi valley region but caused little structural damage because the area was mostly undeveloped at the time.

a) Using a U.S. map or atlas, list two major U.S. cities in the Mississippi valley seismic zone

What lies within the 8 to 32% gravity shake zones (yellow-orange-red).

St Louis and Memphis

b) Explain why the Mississippi valley region, despite experiencing a large magnitude earthquakes in the early 1800s have so few buildings with the types of seismic engineering designs that are so common in California and Japan.

The environment is a challenge, and the area for the buildings to have some engineering structures.

10) The area around Charleston, South Carolina, is another active intraplate seismic zone in the eastern United States. In 1886, a massive magnitude quake occurred near Charleston, causing considerable damage.

a) Using an atlas and Figure 3.5, list the major U.S. cities that lie within the 4 to 24% gravity shake zones (green-yellow-orange) surrounding

Charleston, Savannah Charleston Atlanta and Nashville

b) How well prepared do you think these cities are for a future earthquake? Explain your

Answer.

Due to the new hazard software, it is easier to predict the quake and the engineering structure helps

Ex 3 – Earthquakes

11) Notice in Figure 3.6 how western Washington state lies in a high-risk zone. Here the earthquake risk is related to a convergent plate boundary and associated subduction zone.

Figure 3.6 illustrates how earthquakes are generated along subduction zones.

Figure 3.6 (Source: USGS Fact Sheet 150-00)

a) Explain why the most massive earthquakes on record, around magnitude 9, are found associated

With subduction zones. In other words, what is it about the subduction process itself that generates such large earthquakes?

Boundaries collide in subduction, and crust stores energy released into the earthquakes.

b) Although the Puget Sound and Seattle area in Washington state lies in a high-risk zone, relatively few buildings have incorporated seismic engineering controls similar to those required in California. Explain how this reduced level of preparedness is related to the subduction zone process itself. **This s because of the area s fryer from the zone impact that surrounds the Puget sound that weakens the waves**

12) Communities along the Washington, Oregon, and northern California coast all face the prospect of a major subduction zone earthquake that generates a series of massive tsunami

waves. Describe why it is difficult for emergency management officials to develop effective evacuation procedures for coastal communities should a subduction zone earthquake occur in this area. Hint: examine how tsunamis travel in Figure 3.6.

Tsunamis happen quickly, and evacuation procedures can have more challenge since they can add to more casualties

Ex 3 – Earthquakes