IQRA NATIONAL UNIVERSITY PESHAWER

FINAL TERM PAPER

ENGINEERING GEOLOGY

B-tech(civil)

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Question 1:

How do you define an earthquake? What is your perspective of the necessary measures that should be taken in Pakistan to reduce the destructions caused be Earthquakes?

Earthquake

- Any sudden shaking of the ground caused by the passage of seismic waves through Earth’s rocks.
- Seismic waves are produced when some form of energy stored in Earth’s crust is suddenly released, usually when masses of rock straining against one another suddenly fracture and “slip.”
- Earthquakes occur most often along geologic faults, narrow zones where rock masses move in relation to one another. The major fault\ lines of the world are located at the fringes of the huge tectonic plates that make up Earth’s crust.

Reducing earthquake hazards

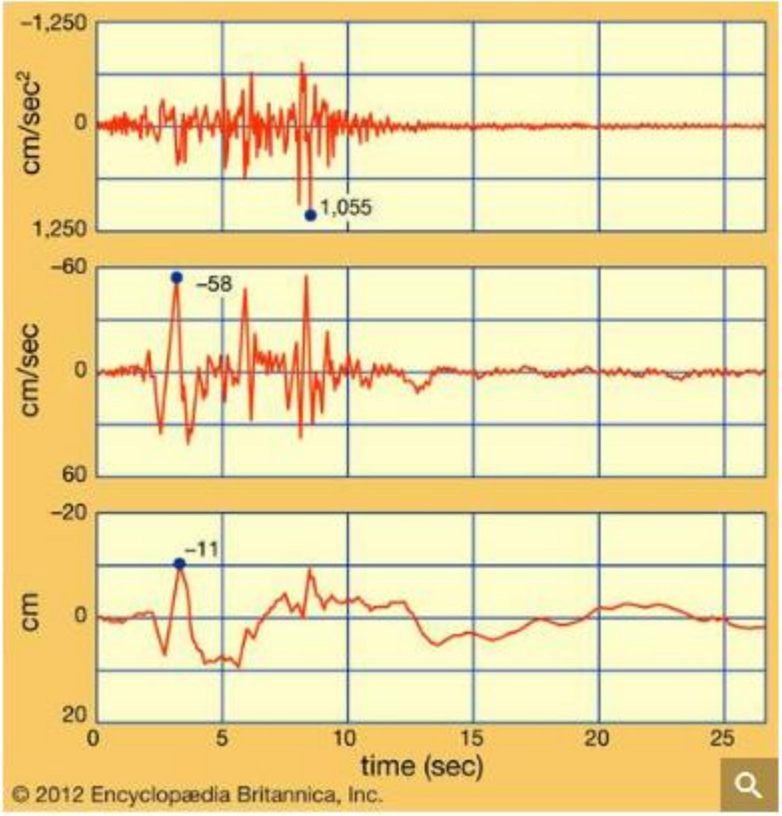
Considerable work has been done in seismology to explain the characteristics of the recorded ground motions in earthquakes. Such knowledge is needed to predict ground motions in future earthquakes so that earthquake-resistant structures can be designed. Although earthquakes cause death and destruction through such secondary effects as landslides, tsunamis, fires, and fault rupture, the greatest losses—both of lives and of property—result from the collapse of man-made structures during the violent shaking of the ground. Accordingly, the most effective way to mitigate the damage of earthquakes from an engineering standpoint is to design and construct structures capable of withstanding strong ground motion

Interpreting recorded ground motions

Most elastic waves recorded close to an extended fault source are complicated and difficult to interpret uniquely. Understanding such near-source motion can be viewed as a three-part problem. The first part stems from the generation of elastic waves by the slipping fault as the moving rupture sweeps out an area of slip along the fault plane within a given time. The pattern of waves produced is dependent on several parameters, such as fault dimension and rupture velocity. Elastic waves of various types radiate from the vicinity of the moving rupture in all directions. The geometry and frictional properties of the fault critically affect the pattern of radiation from it.

The second part of the problem concerns the passage of the waves through the intervening rocks to the site and the effect of geologic conditions. The third part involves the conditions at the recording site itself, such as topography and highly attenuating soils. All these questions must be considered when estimating likely earthquake effects at a site of any proposed structure.

Experience has shown that the ground strong-motion recordings have a variable pattern in detail but predictable regular shapes in general (except in the case of strong multiple earthquakes). An example of actual shaking of the ground (acceleration, velocity, and displacement) recorded during an earthquake is given in the . In a strong horizontal shaking of the ground near the fault source, there is an initial segment of motion made up mainly of *P* waves, which frequently manifest themselves strongly in the vertical motion. This is followed by the onset of *S* waves, often associated with a longer-period pulse of ground velocity and displacement related to the near-site fault slip or fling. This pulse is often enhanced in the direction of the fault rupture and normal to it. After the *S* onset there is shaking that consists of a mixture of *S* and *P* waves, but the *S* motions become dominant as the duration increases. Later, in the horizontal component, surface waves dominate, mixed with some *S* body waves. Depending on the distance of the site from the fault and the structure of the intervening rocks and soils, surface waves are spread out into long trains.



Recording of the San Fernando earthquake, near Pacoima Dam, California, 1971, showing (top) ground acceleration, (centre) velocity, and (bottom) displacement.

Encyclopædia Britannica, Inc.

Constructing seismic hazard maps

In many regions, seismic expectancy maps or hazard maps are now available for planning purposes. The anticipated intensity of ground shaking is represented by a number called the peak acceleration or the peak velocity.

To avoid weaknesses found in earlier earthquake hazard maps, the following general principles are usually adopted today:

1. The map should take into account not only the size but also the frequency of earthquakes.
2. The broad regionalization pattern should use historical seismicity as a database, including the following factors: major tectonic trends, acceleration attenuation curves, and intensity reports.
3. Regionalization should be defined by means of contour lines with design parameters referred to ordered numbers on neighbouring contour lines (this procedure minimizes sensitivity concerning the exact location of boundary lines between separate zones).
4. The map should be simple and not attempt to microzone the region.
5. The mapped contoured surface should not contain discontinuities, so that the level of hazard progresses gradually and in order across any profile drawn on the map.

Question 2:

(a) Briefly describe the history of seismology.

Brief History of Seismology

Every day:

There are about 50 earthquakes strong enough to be felt locally; several of these produce distant seismic waves that can be measured with sensitive instruments anywhere on the globe.

Every few days:

- There is an earthquake strong enough to damage structures.
- Seismology is the scientific study of the seismic waves generated by earthquakes.

Early 1800s

The theory of elastic wave propagation in solid materials is developed by Cauchy, Poisson, Stokes, Rayleigh, and others. They describe primary and secondary body waves (P- and S-waves) and surface waves. (Theory is way ahead of observation.)

1857

R. Mallet, an Irish engineer, travels to Italy to study damage caused by an earthquake near Naples. His work is generally considered to be the first serious attempt at observational seismology. His contributions:

- earthquake waves radiate from a central focus earthquake waves radiate from a central focus
- earthquakes can be located by projecting these waves earthquakes can be located by projecting these waves backward toward the source backward toward the source
- observatories should be established to monitor earthquakes observatories should be established to monitor earthquakes

1875

- F. Cecchi builds the first time-recording seismograph in Italy.
- Higher quality instruments are then developed by British scientists in Japan.
- These early instruments are undamped, and therefore inaccurate after the first few cycles of shaking.

1897

- First seismograph in North America is installed at Lick Observatory near San Jose, California. This instrument will later record the 1906 San Francisco earthquake.

1897

- E. Wiechert develops the first seismometer with viscous damping, capable of producing a useful record for the entire duration of ground shaking.

Early 1900s

- B. B. Galitzen develops the first electromagnetic seismograph in which a moving pendulum generates electric current in a coil, and establishes a network of seismic stations across Russia.

- The new design will prove to be much more accurateand reliable than previous mechanical instruments; all modern seismographs are electromagnetic.

1900-1910

- Seismograms from many earthquakes recorded atmany distances become widely available.
- R. Oldham identifies P-, S-, and surface waves in earthquake records, and detects liquid earth's core from the absence of direct body waves at certain distances.
    - Mohorovicic identifies velocity boundary between, earth's crust and mantle (Moho).
- The first widely-used travel-time tables are publishedby Zöppritz.

1914

B. Gutenberg publishes travel-time tables that include core phases (seismic waves that penetrate or reflect from the core), and accurately estimates the depth of the earth's fluid core (2900 km).

1920s

- Seismic surveying methods using explosions and other artificial sources are developed in the United States for exploring for oil and other resources in the shallow crust.
- \Noise-reducing trace-stacking methods and Vibroseisare developed in the 1950s.

1935

- C. Richter proposes a magnitude scale for specifying the sizes of earthquakes in southern California. The logarithmic Richter scale allows a huge range of earthquake sizes to be conveniently measured.

- Defined for a specific region, specific distance range, specific wave type and period, and specific instrument, the idea is quickly adapted for other cases.
- The smallest felt earthquakes are about magnitude 3, while rare great earthquakes are magnitude 8-9+.

1936

- Lehmann discovers the earth's solid inner core.

1940

- H. Jeffries and K. Bullen publish final versions of their travel-time tables for many seismic phases.
- They are accurate enough to still be in use today

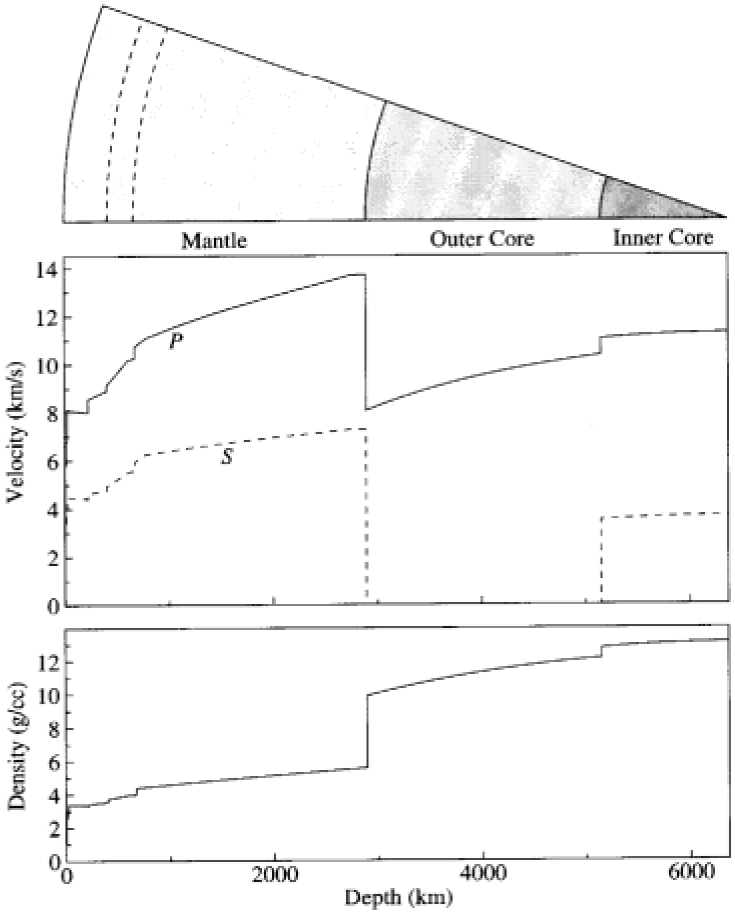


Fig. 1.1. Earth's *P* velocity, *S* velocity, and density as a function of depth. Values are plotted from the Preliminary Reference Earth Model (PREM) of Dziewonski and Anderson (1981); except for some differences in the upper mantle, all modern Earth models are close to these values. PREM is listed as a table in Appendix 1.

1950s & 1960s – The Cold War

- Soviet nuclear tests in the early 1950s generate intense interest by the U.S. military in detection and measurement of nuclear explosions, and funding for government and academic seismology programs surges during the Cold War.
- The Worldwide Standardized Seismograph Network (WWSSN), consisting of well-calibrated short and long-period seismographs, is established in 1961.
- This high-quality dataset will contribute to many advances in seismology.

1966

- The disadvantages of traditional magnitude measures are widely recognized: saturation, inconsistency between magnitude scales, etc. K. Aki introduces "seismic moment", a more physics-based measure of earthquake size.

1960s

- The increased number of seismic stations established after ~1900 allowed large earthquakes to be routinely located. leading to the discovery that earthquakes are not randomly located, but rather are concentrated in narrow belts around the globe. The significance of this observation was not appreciated until the plate tectonics revolution of the 1960s. Earthquakes are generated where crustal plates spread apart (e.g., midAtlantic Ridge), are consumed at subduction zones (e.g., Japan, Aleutians), or slide past each other at transform boundaries (e.g., San Andreas fault).

1960s

- Seismologists show that "focal mechanisms" of large earthquakes inferred from spatial patterns of radiated energy are consistent with plate tectonic ideas, helping to validate the theory.
- Evidence (first presented in 1928 by K. Wadati) of deep earthquakes located along dipping zones of seismicity where crustal plates subduct into the mantle also helps validate plate tectonic theory.

1960s

- Seismologists use records from the great Chilean earthquake of 1960 to study earth's free oscillations. Studies of normal modes excited by large earthquakes provide powerful new constraints on earth's internal structure.

1960s – Computers in Seismology

- Application of computers to larger datasets and problems begins in the 1960s:
- routine earthquake locations routine earthquake locations
- inverse problems inverse problems
- theoretical seismograms theoretical seismograms
- source spectra and scaling; slip distribution on fault source spectra and scaling; slip distribution on fault normal modes normal modes crustal crustal imaging using artificial sources maging using artificial sources

1970s

- First digital global seismographs installed.
- First digital portable seismographs used for special studies (source scaling, site response, etc.).
- Centralized archives of digital seismic data established.

Earthquake Engineering & Seismology

- Destructive earthquakes in southern California in 1933 and 1971 lead to establishment and improvement of seismic elements in building codes in the USA.
- Networks of “strong-motion” seismographs are established and expanded. Unlike conventional seismographs, which are designed for maximum sensitivity, strong-motion instruments can record strong shaking close to damaging earthquakes without saturating.
- A new body of observation and theory addresses the need to estimate damaging (generally high-frequency) ground motions for engineering design.

(b). what is seismoscope? Give a brief explanation of its working principle.

Seismoscope

A seismoscope is an instrument that gives a qualitative measure of the oscillatory motion produced by an earthquake or other disturbance of the earth's surface. Unlike the seismograph, it lacks a device to calibrate the time. Several designs and variations exist, and many are easy to build with common materials. An oscillating cone filled with sand hangs by a string. The sand falls from a hole over a moving surface and draws the waveform that shows the general characteristics of the motion.

Working principle seismoscope

Although we still can't accurately predict earthquakes, humans have come a long way in detecting, recording, and measuring seismic shocks. This process began nearly 2000 years ago, with the invention of the first seismoscope in China.

The First Seismoscope

In 132 CE, inventor, Imperial Historian, and Royal Astronomer Zhang Heng displayed his amazing earthquake-detection machine, or seismoscope, at the court of the Han Dynasty. Zhang's seismoscope was a giant bronze vessel, resembling a barrel almost 6 feet in diameter. Eight dragons snaked face-down along the outside of the barrel, marking the primary compass directions. In each dragon's mouth was a small bronze ball. Beneath the dragons sat eight bronze toads, with their broad mouths gaping to receive the balls.

We don't know exactly what the first seismoscope looked like. Descriptions from the time give us an idea about the size of the instrument and the mechanisms that made it work. Some sources also note that the outside of the seismoscope's body was beautifully engraved with mountains, birds, tortoises, and other animals, but the original source of this information is difficult to trace.

The exact mechanism that caused a ball to drop in the event of an earthquake also is not known. One theory is that a thin stick was set loosely down the center of the barrel. An earthquake would cause the stick to topple over in the direction of the seismic shock, triggering one of the dragons to open its mouth and release the bronze ball.

Another theory posits that a baton was suspended from the lid of the instrument as a free-swinging pendulum. When the pendulum swung widely enough to strike the side of the barrel, it would cause the closest dragon to release its ball. The sound of the ball striking the toad's mouth would alert observers to the earthquake. This would give a rough indication of the earthquake's direction of origin, but it did not provide any information about the intensity of the tremors.

Proof of Concept

Zhang's wonderful machine was called *houfeng didong yi*, meaning "an instrument for measuring the winds and the movements of the Earth." In earthquake-prone China, this was an important invention.
In one instance, just six years after the device was invented, a large quake estimated at a magnitude seven struck what is now Gansu Province. People in the Han Dynasty's capital city of Luoyang, 1,000 miles away, did not feel the shock. However, the seismoscope alerted the emperor's government to the fact that a quake had struck somewhere to the west. This is the first known instance of scientific equipment detecting an earthquake that had not been felt by humans in the area. The seismoscope's findings were confirmed several days later when messengers arrived in Luoyang to report a major earthquake in Gansu**.**

Question 3:

Explain the various Disaster Risks of Pakistan.

Disaster Risks of Pakistan

Pakistan is subject to a range of natural disasters including floods, cyclones, earthquakes, landslides, Climate Change and drought.

1) Earthquakes:

Pakistan lies within a seismic belt and therefore suffers from frequent small and medium magnitude earthquakes (GSP 2001). Earthquakes commonly occur along the Himalayas and Karakorum ranges and parts of Hindu Kush in the north of the country, in the Koh-e-Suleiman Range in the west with Chaman fault line along Quetta, Zob and Mekran fault line affects Gawadar district along the sea of the south-west coast.

2) Cyclones*:*

According to the World Disaster Report 2003, the 960 km long coastal belt of Pakistan is occasionally battered by cyclones causing widespread loss to life and property, especially in the coastal districts of Gawadar, Badin and Thatta.

3) Floods:

Pakistan is one of the five South Asian countries that have the highest annual average number of people physically affected by floods (UNDP 2001). The alluvial plains of the Indus river system formed as flood plains and remain vulnerable to recurrent flooding. Riverine floods occur during the summer monsoons. Flash floods and landslide hazards occur frequently in the northern mountains. Districts along the Indus plain are particularly affected by riverine floods, while hill torrents tend to affect the hilly districts located in the northern and western parts of Pakistan.

4) Landslide

In the area you have selected landslide susceptibility is classified as high according to the information that is currently available. This means that this area has rainfall patterns, terrain slope, geology, soil, land cover and (potentially) earthquakes that make localized landslides a frequent hazard phenomenon. Based on this information, planning decisions such as project siting, project design, and construction methods, must take into account the potential for landslides. Further detailed information should be obtained to better understand the level of landslide susceptibility in your project area.

5) Climate Change In Pakistan

Pakistan is situated in South East Asia.The country is listed in the third world countries. Pakistan consists of four provinces namely Sindh, Punjab, Balochistan, and Khyber Pakhtunkhuwa. • climate Pakistan lies in the subtropical arid zone and most of the country is subjected to a semi-arid climate. Based on physiographic factors and causes of diversity in climate, the country has been classified into four major climatic regions**:**

Climate change impact:

Climate change is likely to alter slope and bedrock stability through changes in precipitation and/or temperature. It is difficult to determine future locations and timing of large rock avalanches, as these depend on local geological conditions and other non-climatic factors.

Climate change Global Warming

Increased Precipitation & its Uneven Distribution Melting of Glaciers & Snow Sea level Rise Increase in Frequency & Intensity of Extreme Weather Events

Effects of global warming on climate of Pakistan

Although Pakistan itself contributes very little to t he overall emissions of the Greenhouse Gases, yet it remains one of the most severely hit countries of the world by the process of Global warming.

Rising temperatures in Pakistan

As an ill effect of global warming, the annual mean surface temperatures in Pakistan have been steadily increasing during the past decad. A rise in mean temperature of 0.6-1°C in the coastal areas along with a 0.5 to 0.7% increase in solar radiation over southern half of country has been observed. In central Pakistan, a 3-5% decrease in cloud cover with increasing hours of sunshine have also been responsible for increasing the temperatures.

6) Drought:

Pakistan is one of the countries that is expected to be hit hardest by the effects of global warming, and drought is one of the possible consequences of global warming resulting in a sharp fall in water table levels and drying up of wetlands (PMD 2002). Districts along the south-western and eastern parts of Pakistan have become severely affected by drought

Question 4:

How does environmental vulnerability add up to the disaster risk of a community?

Vulnerability

The characteristics determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards. The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples may include:

- poor design and construction of buildings,
- inadequate protection of assets,
- lack of public information and awareness,
- limited official recognition of risks and preparedness measures, and
- disregard for wise environmental management.

Environmental Vulnerability

- It is the measure of the health and welfare of the natural environment within the area that either contributes or reduce the propensity of population exposed to potential hazard.
- Poor environmental practices can turn minor events into major disasters. It may include
    - Deforestation,
    - Improper land-use planning,
    - Improper management of hazardous materials, etc.