Name: Shahid Ullah **ID#13639** **Date: 25/6/2020**

(Civil Engineering Department)

(B.Tech Civil)

Engineering Geology, 6th Semester, Final-Assignment **(50 Marks)**

Time: 6hrs

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? (15)

Answer 1

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.
(*See* the table of major earthquakes.)

The response to the earthquake in Pakistan

The earthquake that hit northern Pakistan on 8 October 2005 caused widespread destruction, killing over 73,000 people, severely injuring many more and leaving millions without shelter. The affected areas of Azad Jammu and Kashmir (AJ&K) and North-West Frontier Province (NWFP) suffered extensive structural and economic damage, with vulnerable groups in this mountainous region bearing the brunt of the disaster. The devastation was spread over 30,000 square kilometers of treacherous Himalayan terrain. Most educational institutions were destroyed, killing over 18,000 students. The majority of health care units and hospitals collapsed, the communications infrastructure was unusable

and all essential utilities were disrupted; in all, the affected area was strewn with 200 million tons of debris. Hundreds of post-quake tremors and constant landslides multiplied the shock and trauma, while the onset of winter threatened the lives of the survivors. This was without question the worst natural calamity in Pakistan's history; recovering from it is going to cost billions of dollars.

Measures against earthquakes Personal measures

• Seek shelter under stable tables or under door frames.

• If outside, stay away from buildings, bridges and electricity pylons and move to open areas.

• Avoid areas at risk from secondary processes, such as landslides, rockfall and soil liquefaction.

• After an earthquake, check gas, water and electricity pipes and lines for damage.

• Listen to the radio and follow the instructions issued by the authorities. Technical/biological measures • No measures can be taken to prevent earthquakes themselves, however limited measures exist that can counteract their secondary effects like landslides, rockfall and soil liquefaction.

• Earthquake-proof planning and design of buildings

• The micro zoning of the local geological substratum provides indicators of areas in which tremors will have a particularly strong or attenuated effect. Organizational measures

• At present, earthquake prediction is insufficiently precise to provide the public with sufficient advance warning. For this reason, adequate preparedness and assistance in catastrophes is extremely important in areas affected by earthquakes. Measures of this nature enable numbers of human lives to be saved. Tha only thing you can definitely predict about earth quake is:

- ✓ **The further you are from the last one**
- ✓ **The nearer you are to the next**
- ✓ **Calculate the affected population they become homeless in the earthquake.**
- ✓ **Calculate the time difference between the past earthquake and in present earthquake.**

- ✓ **First of all clear the area from people where the earthquake are mostly occure.**
- ✓ **The building and dam's are constructed on construction think about the factor of safety.**
- ✓ **To update all the device by which record the disaster.**
- ✓ **To make a department for these disaster.**
- ✓ **Also make a doctor team for the emergency.**
- ✓ **Don't construct a multi-story building in those areas where the earthquake enhance are more**

Question 2

(a) Briefly describe the history of seismology.

A 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.**
- **Scientific & Practical Objectives of Seismology:**
- **To learn about the structure of the earth (direct observation To learn about the structure of the earth (direct observation of the deep earth is impossible) and the physics of the deep earth is impossible) and the physics of earthquakes**
- **To make the engineered human environment safer**
- **Seismology is a young science, only about 150 years old.**
- **Before scientific studies began, ideas about earthquakes were largely based on myth and superstition.**

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

Name: Shahid Ullah ID#13639 Date: 25/6/2020

- **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**

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 accurate and reliable than previous mechanical instruments; all modern seismographs are electromagnetic

1906

♣ H. F. Reid, an American engineer, studies survey lines across the San Andreas Fault measured before and after the 1906 San Francisco earthquake. He proposes an “elastic rebound” theory for the origin of earthquakes, where accumulated elastic energy is released suddenly by slip on the fault.

Name: Shahid Ullah **ID#13639** **Date: 25/6/2020**

1900-1910

♣ Seismograms from many earthquakes recorded at many 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.

♣ A. Mohorovicic identifies velocity boundary between earth's crust and mantle (Moho).

♣ The first widely-used travel-time tables are published by 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 Vibroseis are 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

♣ I. Lehmann discovers the earth's solid inner core.

Name: Shahid Ullah **ID#13639** **Date: 25/6/2020**

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.**

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 too 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., mid- Atlantic 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 sub duct into the mantle also helps validate plate tectonic theory.**

Name: Shahid Ullah **ID#13639** **Date: 25/6/2020**

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 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.

Name: Shahid Ullah **ID#13639** **Date: 25/6/2020**

- ♣ **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. (5+5)

Answer

What's 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.

There are few things more disconcerting than the sensation of the seemingly-solid Earth suddenly rolling and pitching beneath one's feet. As a result, humans have sought ways to measure or even predict earthquakes for thousands of years.

Working principle

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.

Chinese Seismoscopes on the Silk Road?

Chinese records indicate that other inventors and tinkerers in the court improved upon Zhang Heng's design for the seismoscope over the centuries that followed. The idea seems to have spread westward across Asia, probably carried along the Silk Road.

By the 13th century, a similar seismoscope was in use in Persia, although the historical record does not provide a clear link between the Chinese and Persian devices. It is possible that the great thinkers of Persia hit upon a similar idea independently.

Question 3:
Explain the various Disaster Risks of Pakistan. (15)

Answer

Natural Hazard Risk

Name: Shahid Ullah ID#13639 Date: 25/6/2020

Pakistan is exposed to a variety of natural hazards. The most damaging are cyclones, droughts, earthquakes, floods, and landslides. In 2005, a high magnitude earthquake caused the greatest destruction and loss recorded in the country's history: 6,700 people died; indirect income losses totaled $576 million; and relief, recovery, and reconstruction cost $5.2 billion.

Natural disasters, including reoccurring flooding, pose a major financing challenge. Flooding causes an estimated annual economic impact of 3–4 percent of the federal budget. In 2010, unprecedented flooding affected the entire length of the country, devastating 78 districts and affecting over 20 million people. A GFDRR-supported damage and needs assessment estimated $10 billion for recovery and reconstruction. In 2011, severe flooding affected 9.6 million people, many of whom were still recovering from the previous year.

The impacts of climate change are projected to increase the frequency and severity of these events.

Government Priorities

Shifting toward proactive disaster risk management (DRM) is a government priority. Following the cataclysmic 2005 earthquake, the National Disaster Management Ordinance of 2006 established the National Disaster Management Authority (NDMA). The national authority coordinates and monitors the implementation of DRM policies and strategies. District Disaster Management Authorities serve as the first line of defense.

In 2013, the National Disaster Risk Reduction Policy outlined a vision for building the NDMA's capacity in risk assessment, prevention, mitigation, and preparedness.

To advance the DRM agenda, priorities include:

- **Improving disaster response and coordination at the national, provincial, and district or city level;**
- **Developing safety nets to mitigate the effects of crises on provinces and shocks on women and children; and,**
- **Identifying and expanding the use of disaster risk financing.**

GFDRR progress to date

GFDRR has supported disaster resilience in Pakistan since 2008. Key areas include damage and loss assessments, hazard and risk assessments, sustainable reconstruction, and disaster risk financing.

Following the 2005 earthquake, GFDRR supported the government's institutional and technical capacity to build a national safety net. The flagship Benazir Income Support Program, established in 2008, provides effective and timely cash assistance to the

vulnerable in the aftermath of disasters. GFDRR also supported the documentation of lessons learned from the post-earthquake Rural Housing Reconstruction Program. The resulting manual now serves as best practice.

Following the 2010 and 2011 flooding, GFDRR supported post-disaster needs assessments (PDNAs). This work assisted the government in determining socioeconomic impacts and in formulating recovery strategies for sustainable reconstruction. Based on recommendations from the 2010 PDNA, over $500 million was leveraged for social protection cash transfers.

Since 2012, GFDRR has supported risk identification and fiscal analysis. This support led to the establishment of a risk assessment unit in the NDMA and a platform to enable data-driven decision-making and investments. GFDRR supports the platform through its Open Data for Resilience Initiative and has trained more than 90 people.

A 2015 fiscal disaster risk assessment report, supported by GFDRR and the World Bank, prompted the government to invest $245 million in disaster resilience, with a focus on fiscal resilience to natural disaster shocks.

GFDRR anticipates continued demand from the Government of Pakistan in the following engagements, which are in the early stages:

- **Building national and regional resilience to weather and climate-related risks through the European Union-South Asia Capacity Building for DRM Program;**
- **Building capacity to integrate geo-hazard risk management into infrastructure programs to ensure the safety of lives and sustainability of investments; and,**
- **Developing community-based approaches to support inclusion and resilience of youth and women in the largest and most populous city, Karachi.**

Question 4:
How does environmental vulnerability add up to the disaster risk of a community? (10)

Environmental Vulnerability

Name: Shahid Ullah ID#13639 Date: 25/6/2020

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.**

Vulnerability may be defined as "The extent to which a community, structure, services or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrains or a disaster prone area." Vulnerabilities can be categorized into physical and socio-economic vulnerability.

Physical Vulnerability:

It includes notions of whom and what may be damaged or destroyed by natural hazard such as earthquakes or floods. It is based on the physical condition of people and elements at risk, such as buildings, infrastructure etc.; and their proximity, location and nature of the hazard. It also relates to the technical 4 capability of building and structures to resist the forces acting upon them during a hazard event. Figure 2 shows the settlements which are located in hazardous slopes. Many landslide and flooding disasters are linked to what you see in the Figure 2. Unchecked growth of settlements in unsafe areas exposes the people to the hazard. In case of an earthquake or landslide the ground may fail and the houses on the top may topple or slide and affect the settlements at the lower level even if they are designed well for earthquake forces.

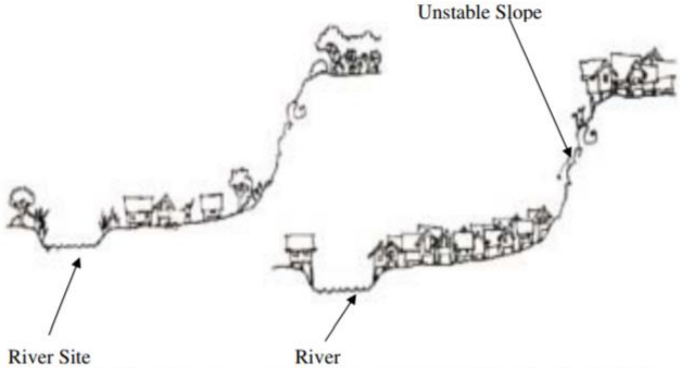

Figure 2: Site after pressures from population growth and urbanization

Name: Shahid Ullah **ID#13639** **Date: 25/6/2020**

Socio-economic Vulnerability:

The degree to which a population is affected by a hazard will not merely lie in the physical components of vulnerability but also on the socioeconomic conditions. The socio-economic conditions of the people also determine the intensity of the impact. For example, people who are poor and living in the sea coast don't have the money to construct strong concrete houses. They are generally at risk and loose their shelters whenever there is strong wind or cyclone. Because of their poverty they too are not able to rebuild their houses.