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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)

Earthquake:

Earthquake also known as quake , tremor or temblor is the phenomenon where there is a sudden release of extreme energy from the earth crust resulting in shaking and displacement of the ground along with the creation of seismic waves. . .

>Earthquakes are the shaking, rolling or sudden shock of the earth's surface.

>They are the Earth's natural means of releasing stress.

>Earthquakes can be felt over large areas although they usually last less than one minute.

>Earthquakes cannot be predicted, although scientists are working on it.

- **Reduction Of Earthquake Due to Destruction:**

Methods of 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 motions.

- **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

- **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:

- The map should take into account not only the size but also the frequency of earthquakes.
- The broad regionalization pattern should use historical seismicity as a database, including the following factors: major tectonic trends, acceleration attenuation curves, and intensity reports.
- Regionalization should be defined by means of contour lines with design parameters referred to ordered numbers on neighboring contour lines (this procedure minimizes sensitivity concerning the exact location of boundary lines between separate zones)
- .The map should be simple and not attempt to micro zone the region.
- 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.

- **Developing Resistant Structures:**

Developing engineered structural designs that are able to resist the forces generated by seismic waves can be achieved either by following building codes based on hazard maps or by appropriate methods of analysis. Many countries reserve theoretical structural analyses for the larger, more costly, or critical buildings to be constructed in the most seismically active regions, while simply requiring that ordinary structures conform to local building codes. Economic realities usually determine the goal, not of preventing all damage in all earthquakes but of minimizing damage in moderate, more common earthquakes and ensuring no major collapse at the strongest intensities. An essential part of what goes into engineering decisions on design and into the development and revision of earthquake-resistant design codes is therefore seismological, involving measurement of strong seismic waves, field studies of intensity and damage, and the probability of earthquake occurrence.

- **Reduced By Rapid Post-Earthquake Response:**

Earthquake risk can also be reduced by rapid post-earthquake response. Strong-motion accelerographs have been connected in some urban areas, such as Los Angeles, Tokyo, and Mexico City, to interactive computers. The recorded waves are correlated with seismic intensity scales and rapidly displayed graphically on regional maps via the World Wide Web.

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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.

 Seismology is a young science, only about 150 years old.

 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.)

 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:

- **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.

- **1906**

 H. F. Reid, an American engineer, studies survey lines across the San Andreas fault measured before and after the 1906 San Francisco earthquake

- **1900-1910**

 Seismograms from many earthquakes recorded at many distances become widely available.

- **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 andother artificial sources are developed in the United States for exploring for oil and other resources in the shallow crust.

- **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.

 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.

- **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.

- **1966**

 The disadvantages of traditional magnitude measures are widely recognized: saturation, inconsistency between magnitude scales, etc.

- **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.

 Seismologists use records from the great Chilean earthquake of 1960 to study earth's free oscillations.

- **1970s**

 First digital global seismographs installed.

 Centralized archives of digital seismic data established.

(b) What is seismoscope? Give a brief explanation of its working principle. (5+5)

Seismoscope:

- An instrument that documents the occurrence of ground motion (but does not record it over time)
- an instrument for recording the occurrence or time of an earthquake

Principles Of Working :

Zhang Heng, Wade-Giles romanization Chang Heng, (born 78 CE-died 139), Chinese mathematician, astronomer, and geographer. His seismoscope for registering earthquakes was apparently cylindrical in shape, with eight dragons' heads arranged around its upper circumference, each with a ball in its mouth. Below were eight frogs, each directly under a dragon's head. When an earthquake occurred, a ball dropped and was caught by a frog's mouth, generating a sound.

An early seismic instrument called the seismoscope made no time record of ground oscillations but simply indicated that shaking had occurred. A Chinese scholar, Zhang Heng, invented such an instrument as early as 132 CE. It was cylindrical in shape with

eight dragon heads arranged around its upper circumference, each with a ball in its mouth. Around the lower circumference were eight frogs, each directly under a dragon head. When an earthquake occurred, balls were released from a dragon's mouth, probably by an internal pendulum that moved back and forth according to the direction of vibration, and were caught by a frog's mouth, which produced noise.

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

Natural Disaster Risk of Pakistan:

A natural disaster is a major adverse event resulting from natural processes of the Earth. Pakistan is subject to a range of natural disasters including floods, cyclones, earthquakes, landslides and drought. In this subsection we summarize some basic facts concerning four of the major hazards, which are relevant to this hazard risk and vulnerability study.
Examples are these:

1. Earthquakes & Tsunamis:

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.

Worst earthquake of 20th in Pakistan:

 This Earthquake was a magnitude of 6.2 and hit Hunza, Hazara and Swat districts of northern Pakistan on December 28, 1974.
 The quake had a shallow focal depth and was followed by numerous aftershocks.
 An official estimate of the number killed was 5,300 with approximately 17,000 injured. A total of 97,000 were reported affected by the tremor.
 Most of the destruction was centred around the village of Pattan, located about 100 miles north of the capital city of Islamabad.
 The village was almost completely destroyed. Landslides and rock falls contributed to the damage.

2005 Kashmir earthquake:

 A 7.6-Richter scale quake struck the Kashmir region on the India-Pakistan border and parts of northwestern Pakistan on 8 October 2005.
 According to official figures, at least 73,000 people were killed and more than 3.3 million made homeless.
 Work even continues today to rebuild damaged infrastructure.

2. 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.

Worst natural disaster in 21st century:

 Up till now that is 2011, some of major disasters have occurred in Pakistan from 2005 Earthquake to 2010 floods.

 Following is the worst natural disasters in Pakistan from 2000 till 2011;

Drought of 1998-2002:

 The drought of 1998-2002 is considered worst in 50 years in Pakistan. The drought started in 1997 as El-Nino developed, but the drought gained intensity in 1998 and reached its peak in 2000 till 2001 and thus gradually weakened in 2002.

 The extreme drought also affected much of India and Afghanistan.

 The World Bank warned that the drought would inevitably hit economic growth of Pakistan.

 Thus it denoted several hundred-million dollars to help Pakistan through its worsening drought.

3. Cyclons:

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.

1964 Indus valley cyclone & 1993 Pak –indo cyclone:

 1964 cyclone made landfall in Tharparkar and Hyderabad district in Sindh province in Pakistan on 12 June.

 However it caused a great loss of life and property in the province. It killed 450 people and left some 400,000 people homeless.

 1993 cyclone weakened over the sea near Sindh- Gujrat border due to high wind shear.

 However it caused massive rainfall and flooding in Karachi but Thatta and Badin districts were the worst affected where

 The cyclone killed 609 people and displaced some 200,000 others.

Cyclone Karachi:

 It killed 200 people alone in Karachi city on 23 June due to heavy rainfall and intense windstorms of 70 mph.

 It made landfall near the towns of Ormara and Pasni in the Balochistan province on 26 June where it killed 300 people.

 Overall it killed 730 people and affected the lives of 2 million people in Pakistan making it the third deadliest cyclone in the history of the country.

4. 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.

2010 Pakistan flood:

- 2,000 people lost their lives in these floods in Pakistan and over 20 million affected.
- Pakistan had sought international help to cope with the catastrophe.
- Despite mass evacuations, there were fears the death toll will rise as flooding reached the southern province of Sindh and the risk of water-borne disease outbreaks increased in many areas. Still many people are living in camps after one year has passed by.

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

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.

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.

makes people vulnerable to disaster risk:

Vulnerability is the human dimension of disasters and is the result of the range of economic, social, cultural, institutional, political and psychological factors that shape people's lives and the environment that they live in (Twigg, 2004).

Vulnerability can be a challenging concept to understand because it tends to mean different things to different people and because it is often described using a variety of terms including 'predisposition', 'fragility', 'weakness', 'deficiency' or 'lack of capacity'.

Some definitions of vulnerability have included exposure in addition to susceptibility to harm. However, it is now understood that exposure is separate to the 'susceptibility' element of vulnerability since it is possible to be exposed, whilst at the same time not susceptible to natural hazard