Engineering Geology

Final Paper

Submitted By: Muhammad Adeel

Class ID: 16115

Section: A

Instructor: Engr. Imtiaz Khan

Department: Civil Engineering

Semester: 2

Dated: 25-06-2020

Signature

____

IQRA NATIONAL UNIVERSITY

HAYATABAD, PESHAWAR

Q1: What causes earthquakes? If the Richter magnitude reaches at 8 or above what will be the consequences? Differentiate primary and secondary waves?

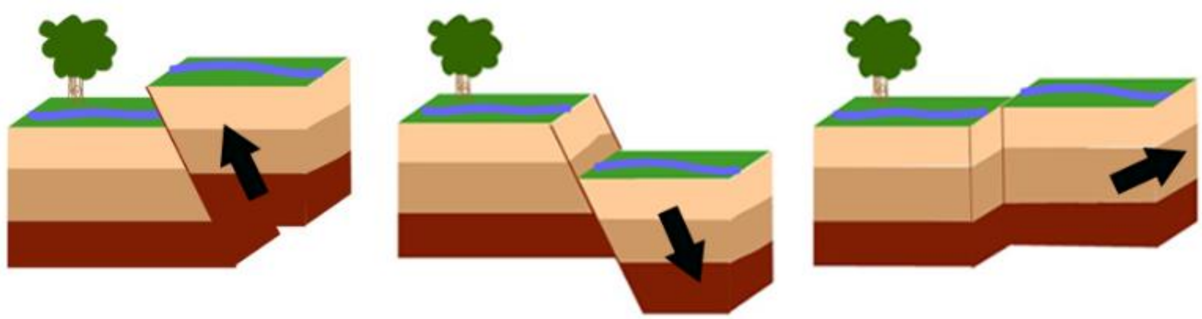
Definition

An earthquake is caused by a sudden slip on a fault. When the stress on the edge overcomes the friction, there is an earthquake that releases energy in waves that travel through the earth's crust and cause the shaking that we feel.

Causes Of Earthquakes

The Earth's crust consists of seven large lithospheric plates and numerous smaller plates. These plates move towards each other (a convergent boundary), apart (a divergent boundary) or past each other (a transform boundary).

Earthquakes are caused by a sudden release of stress along faults in the earth's crust. The continuous motion of tectonic plates causes a steady build-up of pressure in the rock strata on both sides of a fault until the stress is sufficiently great that it is released in a sudden, jerky movement. The resulting waves of seismic energy propagate through the ground and over its surface, causing the shaking we perceive as earthquakes.



Thrust Fault (convergent) Normal Fault (divergent) Strike-Slip Fault (trasform)

1. Tectonic Earthquakes

Earthquakes caused by plate tectonics are called tectonic quakes. They account for most earthquakes worldwide and usually occur at the boundaries of tectonic plates.

2. Induced Earthquakes

Induced quakes are caused by human activity, like tunnel construction, filling reservoirs and implementing geothermal or fracking projects.

3. **Volcanic Earthquakes**

Volcanic quakes are associated with active volcanism. They are generally not as powerful as tectonic quakes and often occur relatively near the surface. Consequently, they are usually only felt in the vicinity of the hypocenter.

4. **Collapse Earthquakes**

Collapse quakes can be triggered by such phenomena as cave-ins, mostly in karst areas or close to mining facilities, as a result of subsidence.

Richter magnitude reaches at 8 or above

The consequences when an earthquake reaches 8 or above will do a damage and will destroy building, bridges and roads.

Differentiate primary and secondary waves

Primary Waves	**Secondary Waves**
High frequency	High frequency
Short wavelength	Short wavelength
Longitudinal waves	Transverse waves
Pass through solids and liquids	Cannot pass through liquids
Moves forwards and backwards as it compressed and decompressed	Move in all direction from their source
P-wave is faster	S-wave is more slower than P-wave
First P-wave arrive	After P-wave S-wave is arrive
Typical speeds are 330 m/s in air, 1450 m/s in water and about 5000 m/s in granite.	they travel 1.7 times slower from P-wave

Q2: Describe the role of geology in selection of sites for dams and reservoirs?

Dams

A dam is a barrier or large impounding structure designed and constructed on a water course to confine large volume of water and then control the flow of water. It will retain water at the upstream side of the structure.

Selection of Dam Site

Narrow River Valley

At proposed dam site, if the river valley is narrow, a small dam is required which reduces the cost of construction.

A Few defects at narrow river valley are as follows

- Narrowing of valley due to landslides, rock creep, rock fracturing, thick superficial deposits such as residual soil, talus, boulders, silt and clay etc.,
- The occurrence of buried river channels crossing the site, either below or adjacent to river bed.
- Unsuitability of rocks due to presence of soluble minerals like gypsum or due to faulting which may be concealed beneath sediments.

Topographically

A place which is most suitable for the purpose is selected. Ideally it should be narrow or a small valley with enough catchment areas available behind so that when a dam is placed there it would be easily store a calculated volume of water in reservoir created upstream. Technically, the site should be as sound as possible, strong, impermeable and stable. Strong rocks for design, impermeable for inventory of stored water and stability with references to seismic failures.

Constructionally

The site should not be far from deposits of materials which would be required for construction.

Economically

The benefits arising out of a dam is proposed to be placed at a particular site should be realistic and justified in terms of land irrigated, power generated and water stored.

Geological Investigations

Following geological characters of the area should be investigated for particular site selected for dam – Geology of area comprising of main topographical features, natural drainage patterns, general characters and structures of rock formations, the trend and type of weathering and erosion of area.

- Geology of site i.e. types of rocks of the area where dam will be built, properties of rocks i.e. chemical composition, texture and hardness of rocks, porosity and permeability of rocks.
- Structural features of the rock i.e. dip, strikes, outcrop etc. Structural defect of rocks i.e. folds, fissures, faults etc.
- Crushing and shearing strength of rocks, extent of weathering of rocks. • Thickness of the bedding planes.
- Zones of fractures and weaknesses.
- Water table in the area
- The ideal foundation should be built over a uniform formation.
- The underlying rocks should be strong enough to bear weight of dam and to withstand resultant thrust of pressure of the impounded water and weight of dam itself.

Preliminary Investigation

- Lithology: It provides details of rock type present, their nature and extent of weathering, occurrence of rock and soil debris etc., in that area.
- Structure: It provides information on strike, dip of beds and also details of folds, faults, joints and unconformities.
- Topography: It provides information on surface features like valley, hills, trend of river, stability of slope, scope for occurrence of landslide. The rough assessment of depth of bed rock.
- Ground Water Conditions: It provides information on springs, seepages, wells etc., which provides information on scope for leakage and present of any cavities.

Detailed Investigation

- Surface Investigation: preparation of geological map of the area, important such as compressive & tensile strength, porosity, permeability, durability etc., The details on orientation of bedding planes, thickness of bedding planes and any intrusions if present any.

- Sub-Surface Investigation: Geo-physical investigations to know the sub-surface profile. Drilling of bore holes will gives detailed information on cavities & fractures present and also helps in verifying the Geo-physical investigations

RESERVIOR

A reservoir usually means an enlarged natural or artificial lake, storage pond or impoundment created using a dam to store water. Reservoirs can be created by controlling a stream that drains an existing body of water. They can also be constructed in river valleys using a dam.

Purpose of a Reservoir

Reservoirs may be managed to balance some or all of the following activities

- Water supply
- Flood control
- Soil erosion
- Environmental management
- Hydroelectric power generation
- Navigation
- Irrigation

Capacity of the Reservoir

Reservoir capacity depends on the existing topography and the proposed top water level (TWL) of the reservoir.

Effect of Evaporation

The natural process of evaporation reduces the quantity of water in the reservoir. Through unwanted, this process is unavoidable. Since reservoirs are open and extended over larger areas. The magnitude of evaporation will be extensive. Of course, such loss shall be less if the topography is such that a reservoir covers a small area but has a great depth to provide adequate capacity.

Q3: What are the different types of mass wasting? Also explain the protective measures of landslides?

Mass wasting

Mass wasting, also known as slope movement or mass movement, is the geomorphic process by which soil, sand, regolith, and rock move downslope typically as a solid, continuous or discontinuous mass, largely under the force of gravity, frequently with characteristics of a flow as in debris flows and mudflows.

Types of mass wasting

Slump

The term slump refers to a slipping of coherent rock material along the curved surface of a decline. Slumps are also called as Rotational Slides due to the type of movement involved. These are special category slides wherein the downward rotation of rock or regolith occurs along a concave- upward curved surface. Heavy rains, tectonic disturbances, tremors and earthquakes can also trigger slumps. Slump.

Flow

Movement of soil and regolith resembling like a fluid behavior is called as a flow. These include avalanches, mudflows, debris flows, earth flow, lahars. Water, air and ice are often involved in enabling this fluid like motion of the material.

Rock and Debris slides

Slides are sudden downhill movement of masses of rock or sediment or soils. Slides are also called Translational Slides, as they involve only straight movement along a direction. Rock slides and debris slides result when rocks or debris slide down a pre-existing surface, such as a bedding plane, foliation surface, or joint surface. Piles of talus are common at the base of a rock slide or debris slide. Slides differ from slumps in that there is no rotation of the sliding rock mass along a curved surface.

Rock and Debris Fall

Falls are major categories of mass-wasting. Falls are further categorized into two types as rock falls or debris falls. Rock falls occur when a piece of rock on a steep slope becomes dislodged and falls down the slope. Debris falls are similar, except they involve a mixture of soil, regolith, vegetation, and rocks.

Creep

Creep is a very slow mass movement that goes on for years or even centuries. You can't see creep happening but leaning fences and poles and broken retaining walls show where it has taken place. This mass wasting is the result of freezing/thawing and wetting/drying cycles. Sediment expands and particles are lifted up at right angles to the slope, when they freeze, get wet or are heated up in the sun. When the sediments shrink, the particles fall straight back down. Creep takes a long time because each particle might only move a millimeter to a few centimeters at a time.

Permafrost

Layer of permanently frozen ground, known as permafrost, occurs where summers are too cool to melt more than a shallow surface layer. It refers to the permanently frozen ground that occurs in climates in which annual air temperature is low enough to maintain a continuous surface temperature below 0℃.In permafrost the depth to which water freezes exceeds the depth of summer thawing.

Solifluction

Special type of creep which occurs in regions underlain by permafrost (permanently frozen, water- bearing ground). During warm periods top portion (active layer) thaws and becomes saturated, but melt water is unable to percolate into permafrost layer below. Saturated (active) layer starts flowing over frozen layers very slowly. It can occur on slopes even as gentle as 2-3 degree.

Protective measures of landslides

Flattening of the slope

At the point of failure may be stabilized by grading the slope to a flatter angle on the basis of proper geotechnical investigation. Done either by regarding the slope from bottom to the top with benching, wherever necessary or cut in upper hills.

Stitching of the debris cover to the rock

Movement of surface soil can be controlled by stitching the debris to the base rock with help of micro-piles (e.g. timber piles)

Retaining walls

Built at the bottom of the slope but the base of the wall should be properly anchored into the rock. Big landslides cannot be controlled by retaining walls.

Grouting

Effective method of improving the shear strength and decreasing the permeability of coarse-grained soil. Suitable for filling voids in the rock mass. Cement grouts are injected under pressure to close the voids in the rock.

Geotextiles

Wrapped filler drains are inserted into the slope extending beyond the estimated slip surface. They are connected to a crib wall at the base which is made of crushed rock to provide drainage of water from the transverse drain.

Rock fall Protection

In many areas rock faces are ‘stitched’ with massive steel bolts to try to keep material from being lost to active weathering. Alternately, surfaces can be covered with strong mesh or boulder catching nets can be used.

Mudflow Barriers

These kinds of barriers are designed to catch most sediment, but are not capable of stopping very large and very fast moving debris.

Debris Basins

These require periodic (regular) removal of trapped material. The hazard from landslides can be reduced by avoiding construction on steep slopes and existing landslides, or by stabilizing the slopes.

Q4: Differentiate fault, joint and fold?

Fault

In geology, a fault is a planar fracture or discontinuity in a volume of rock across which there has been significant displacement as a result of rock-mass movement. Large faults within the Earth's crust result from the action of plate tectonic forces.

Joint

A joint is a break of natural origin in the continuity of either a layer or body of rock that lacks any visible or measurable movement parallel to the surface of the fracture. Although they can occur singly, they most frequently occur as joint sets and systems.

Fold

A fold occurs when one or a stack of originally flat and planar surfaces, such as sedimentary strata, are bent or curved as a result of permanent deformation.

(a) What do the normal faults cause to the crust of the Earth?

Ans: Due to the inclines nature of the fault plane and downward displacement of a part of the strata, normal faults cause an extension in the crust wherever they occur

(b) Folds develop in which type of rock?

Ans: In sedimentary rocks

(c) What is the effect of faulting on outcrop?

Ans: The most prominent effect observed after faulting and erosion of the up thrown block is a horizontal shift between the two parts of the outcrop.

(d) Where should a site for a civil engineering project be located?

Ans: Must be avoided to possible extent to be built on all three

Q5: Describe tunneling on the basis of geology? Also determine geological investigation for tunnels?

Tunnel In Geology

Tunneling is a serious engineering project. In addition to large investment cost, the challenges related to long and deep tunnels are the site characteristics along the alignment routes.

Geology plays a very important role in this. Any adverse and unforeseen geological conditions may influence the safety of tunnels, loss of life, construction time and costs. When a tunnel or shaft is excavated, the rock stresses are perturbed around the opening and displacements will occur.

Geological Investigation for Tunnels

1. Selection of the alignment, cross section, and construction methods is influenced by the geological and geotechnical conditions, as well as the site constraints.
   Good knowledge of the expected geological conditions is essential. Tunnel alignment is sometimes changed based on the results of the geotechnical to minimize construction cost or to reduce risks.

2. The type of the ground encountered along the alignment would affect the selection of the tunnel type and its method of construction.

3. Study of the impact of geological features on the tunnel alignment in the presence of active or inactive faults. During the planning phase, avoid crossing a fault zone. If it is un avoidable then proper measures for crossing it should be implemented. Presence of faults or potentially liquefiable materials would be of concern during the planning process.

4. Geotechnical issues such as the soil or rock properties, the ground water regime, and the ground cover over the tunnel should be analyzed. The investigation should address not just the soil and rock properties, but also their anticipated behaviors during excavation.

5. The investigation should also address groundwater. For example, in soft ground SEM tunneling, the stability of the excavated face is greatly dependent on control of the groundwater. Dewatering, pre-draining, grouting, or freezing are often used to stabilize the excavation.

6. Analyzing the ground behavior during tunneling will affect potential settlements on the surface. Measures to minimize settlements by using suitable tunneling methods or by preconditioning the ground to improve its characteristics would be required.

7. Risk assessment is an important factor in selecting a tunnel alignment. Construction risks. Sensitive existing structures. Very Hard spots (rock, for example) beneath parts of a tunnel.