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

ANSWER:

Causes of Earthquake:

Earth's crust ranges from 3 to 45 miles deep (5 to 70 kilometers). The crust is a thin, hard shell that floats on the denser, hotter rock of the mantle. The crust is divided into several pieces known as tectonic plates that are constantly in motion, grinding past one another at boundaries known as faults.

As they slide past one another, the tectonic plates snag on rough patches of rock. They lock together like Velcro. However, even though the fault boundaries are locked together, the plates still move, pulling at the entangled sections. This pulling can further crack the Earth's crust, creating more faults near the plate boundaries.

An earthquake occurs when the pressure built up along a fault becomes stronger than the pressure holding the rocks together. Then the rocks on either side of the fault suddenly rip apart, sometimes at supersonic speeds. The two sides of the fault slide past one another, releasing the pent-up pressure. Energy from this separation radiates outward in all directions, including towards the surface, where it is felt as an earthquake.

Consequences:

Intensity 10: Extreme — Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations.

Intensity 9: Violent — Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.

Intensity 8: Severe — Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, roads, walls. Heavy furniture overturned.

Primary Waves:

Compression waves are one type of seismic wave. They are the first to arrive at the surface of the Earth. Because of this they are given another name, **P or Primary waves.**

P waves are the fastest of the seismic waves. They travel at incredible speeds, 14,000 m.p.h at the surface to over 25,000 m.p.h. through the core of the Earth. P waves are even able to pass all the way through the entire Earth.

When P waves strike an object they push and pull the object , like a train engine bumping into a railroad car which then bumps into another and so on all the way through the whole length of the train. This jackhammer movement is the first sign that an earthquake is occurring.

As a wave passes through a house, the house is pushed and pulled. If the house is not strong enough it might collapse.

Secondary Waves:

Shear waves reach the surface shortly after the P waves and are given the name **S or Secondary waves.** S waves travel at about half the speed of P waves. They move objects in their paths in an up and down motion in the direction that the wave is moving.

S waves can only move through solids and because of this can travel only through the crust and mantle of the Earth. When S waves strike the outer core, which is made of liquid iron and nickel, the waves stop.

1. Describe the role of geology in selection of sites for dams and reservoirs?

ANSWER:

Geological investigation for selecting and locating dam sites is one of the most significant studies which should be carried out in different scales and stages before deciding the best location for a dam. Therefore, an adequate assessment of site geologic and geotechnical conditions is one of the most significant aspects of a dam safety evaluation. Evaluation of the safety of a new dam requires, among other things, that its site, abutments, foundation and reservoir have been adequately examined, explored, and investigated so that the geological conditions are fully understood as much as possible.

The geological investigations for dams should include four main topics:

These are:

1. The geology of the dam site including the foundation for the dam itself and the sites for other structures such as spillway, diversion tunnel and outlet works. To check whether

the dam foundation has sufficient strength and durability to support the type of dam proposed, whether the foundation is watertight, especially, when karstified rocks occur in the site and in deeper horizons bellow the foundations.

2. The geology of the area to be occupied by the reservoir once the dam is completed. Whether the storage area is watertight or are there areas of cavernous limestone and/or gypsum which might lead to the dam not retaining water.

3. Stability of the slopes in the dam site and reservoir area whether landslides into the reservoir are possible which might cause a wave of water to be pushed over the top of the dam.

4. Finding sources of the construction materials which will be needed to build the dam in nearby areas of the dam site including all required types like: aggregates of different types and sizes, filling materials in the core and both surfaces (if the dam is of earth-fill type).

Geological Consideration in Selection of Dam Site:

- Narrow River Valley
- Occurrence of Bedrock at a shallow Depths
- Competent rocks to offer Stable Foundations
    - Suitability of different types of rocks
    - Influence of weathering
    - Effect of occurrence of intrusions
    - Effect of fracturing
- Effect of Associated Geological Structures
- Leakage below Dams

2. What are the different types of mass wasting? Also explain the protective measures of landslides?

ANSWER:

TYPES OF MASS WASTING:

The most common mass-wasting types are falls, rotational and translational slides, flows, and creep.

Falls are abrupt rock movements that detach from steep slopes or cliffs. Rocks separate along existing natural breaks such as fractures or bedding planes. Movement occurs as free-falling, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and water.

Rotational slides commonly show slow movement along a curved rupture surface.

Translational slides often are rapid movements along a plane of distinct weakness between the overlying slide material and more stable underlying material. Slides can be further subdivided into rock slides, debris slides, or earth slides depending on the type of the material involved.

Flows are rapidly moving mass-wasting events in which the loose material is typically mixed with abundant water, creating long runouts at the slope base. Flows are commonly separated into **debris flow** (coarse material) and **earthflow** (fine material) depending on the type of material involved and the amount of water. Some of the largest and fastest flows on land are called **Sturzstroms**, or long runout landslides. They are still poorly understood, but are known to travel for long distances, even in places without significant atmospheres like the Moon.

Creep is the imperceptibly slow downward movement of material caused by shear stress sufficient to produce permanent deformation in unconsolidated material. Creep is indicated by curved tree trunks, bent fences or retaining walls, tilted poles or fences, and small soil ripples or ridges. A special type of soil creep is solifluction, which is the slow movement of soil lobes on low-angle slopes due to soil repeatedly freezing and thawing in high-latitude,typically sub-Arctic, Arctic, and Antarctic locations.

Protective measures of landslides:

Improving surface and subsurface drainage:

Because water is a main factor in landslides, improving surface and subsurface drainage at the site can increase the stability of a landslide-prone slope. Surface water should be diverted away from the landslide-prone region by channeling water in a lined drainage ditch or sewer pipe to the base of the slope. The water should be diverted in such a way as to avoid triggering a landslide adjacent to the site. Surface water should not be allowed to pond on the landslide-prone slope.

Ground water can be drained from the soil using trenches filled with gravel and perforated pipes or pumped water wells. Swimming pools, water lines, and sewers should be maintained to prevent leakage, and the watering of lawns and vegetation should be kept to a minimum. Clayey soils and shales have low hydraulic conductivity and can be difficult to drain.

Excavating the head:

Removing the soil and rock at the head of the landslide decreases the driving pressure and can slow or stop a landslide. Additional soil and rock above the landslide will need to be removed to prevent a new landslide from forming upslope. Flattening the slope angle at the top of the hill can help stabilize landslide-prone slopes.

Buttressing the toe:

If the toe of the landslide is at the base of the slope, fill can be placed over the toe and along the base of the slope. The fill increases the resisting forces along the failure surface in the toe area. This, in turn, blocks the material in the head from moving toward the toe. However, if the toe is higher on the slope, adding fill would overload the soil and rock below the toe, thus causing a landslide to form downslope of the fill.

Constructing piles and retaining walls:

Piles are metal beams that are either driven into the soil or placed in drill holes. Properly placed piles should extend into a competent rock layer below the landslide. Wooden beams and telephone poles are not recommended for use as piles because they lack strength and can rot.

Because landslides can ooze through the gaps between the piles, retaining walls are often constructed. Retaining walls can be constructed by adding lagging (metal, concrete, or wooden beams) horizontally between the piles. Such walls can be further strengthened by adding tiebacks and buttressing beams. Tiebacks are long rods that attach to the piles and to a competent rock layer below the ground surface. Buttressing beams are placed at an angle downslope of the piles to prevent the piles from toppling or tilting. Retaining walls also are constructed of concrete, cinder blocks, rock, railroad ties, or logs, but these may not be strong enough to resist landslide movement and could topple.

Removal and replacement:

Landslide-prone soil and rock can be removed and replaced with stronger materials, such as silty or sandy soils. Because weathering of shales can form landslide-prone soils, the removal and replacement procedure must include measures to prevent continued weathering of the remaining rock. Landslide material should never be pushed back up the slope. This will simply lead to continued motion of the landslide.

Preserving vegetation:

Trees, grasses, and vegetation can minimize the amount of water infiltrating into the soil, slow the erosion caused by surface-water flow, and remove water from the soil. Although vegetation alone cannot prevent or stop a landslide, removal of vegetation from a landslide-prone slope may initiate a landslide.

Rock fall protection:

Rock falls are contained by (1) ditches at the base of the rock exposure, (2) heavy-duty fences, and (3) concrete catch walls that slow errant boulders that have broken free from the rock outcrop. In some cases, loose blocks of rock are attached to bedrock with rock bolts, long metal rods that are anchored in competent bedrock and are threaded on the outside for large nuts. A metal plate with a center hole, like a very large washer, is placed over the end of the rod where it extends from the loose block, and the nut is then added and tightened. Once constructed, remedial measures must be inspected and maintained. Lack of maintenance can cause renewed landslide movement.

3. Differentiate fault, joint and fold?

ANSWER:

- **FOLD:** Permanent wavelike deformation in layered rock or sediment.
- **FAULT:** A fracture in bedrock along which rocks on one side have moved relative to the other side.
- **JOINT:** A fracture on a rock without noticeable movement.

A. What do the normal faults cause to the crust of the Earth?

ANSWER:

Large faults within the Earth's crust result from the action of plate tectonic forces, with the largest forming the boundaries between the plates, such as subduction zones or transform faults. Energy release associated with rapid movement on active faults is the cause of most earthquakes.

B. Folds develop in which type of rock?

ANSWER:

a) Shortening of crest
b) Cracking of crest
c) Extension in the crust
d) Strengthening of crust

Explanation:

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.

C. What is the effect of faulting on outcrop?

ANSWER:

Effects of Faulting on Outcrops:

Faults invariably change the original position of the outcrops traversed by them. These changes depend primarily on the type of the fault, the attitude of the fault, and the nature and attitude of the disrupted rock. Thus, effects produced by strike-slip fault shall differ markedly from those produced on the same rock by a dip-slip fault and so on.

(A) Strike Faults:

Strike faults are those, which are developed parallel to the strike of the outcrops. These faults produce, besides other changes, two pronounced effects on the outcrops- repetition and omission of strata.

Repetition of the strata occurs when the downthrow is against the direction of the dip of the bed in which faulting has taken place.

Omission of the strata takes place in a strike fault when the downthrow is parallel to the direction of the dip of the faulted bed.

(B) Dip Faults:

In dip faults which occur parallel to the dip of the outcrop, the most prominent effect observed after faulting and erosion of the upthrown block is a horizontal shift between the two parts of the outcrop.

(C) Oblique Faults:

These faults cause an offset in the sequence, which is associated with either a gap or an overlap depending upon the downthrow direction.

Thus:

(i) Oblique faults with downthrow to the left side result in an offset with an overlap;

(ii) Oblique faults with downthrow to the right side result in an offset with a gap.

D. Where should a site for a civil engineering project be located? a) On faulted zone b) on folded strata c) On a joint d) Must be avoided to possible extent to be built on all three.

ANSWER:

As far as possible the location of a civil engineering project must be avoided on a fault or a fold or a joint. But when there is no other choice, the same location can be treated with necessary methods and then the project can be implemented.

4. Describe tunneling on the basis of geology? Also determine geological investigation for tunnels?

ANSWER:

Tunnels are generally grouped in four broad categories, depending on the material through which they pass: soft ground, consisting of soil and very weak rock; hard rock; soft rock, such as shale, chalk, and friable sandstone; and subaqueous. While these four broad types of ground condition require very different methods of excavation and ground support, nearly all tunneling operations nevertheless involve certain basic procedures: investigation, excavation and materials transport, ground support, and environmental control. Similarly, tunnels for mining and for civil-engineering projects share the basic procedures but differ greatly in the design approach toward permanence, owing to their differing purposes. Many mining tunnels have been planned only for minimum-cost temporary use during ore extraction, although the growing desire of surface owners for legal protection against subsequent tunnel collapse may cause this to change. By contrast, most civil-engineering or public-works tunnels involve continued human occupancy plus full protection of adjacent owners and are much more conservatively designed for permanent safety. In all tunnels, geologic conditions play the dominant role in governing the acceptability of construction methods and the practicality of different designs. Indeed, tunneling history is filled with instances in which a sudden encounter with unanticipated conditions caused long stoppages for changes in construction methods, in design, or in both, with resulting great increases in cost and time. At the Awali Tunnel in Lebanon in 1960, for example, a huge flow of water and sand filled over 2 miles of the bore and more than doubled construction time to eight years for its 10-mile length.

Investigation:

1. Geotechnical investigations are critical for proper planning of a tunnel.

2. 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.

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

4. 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 unavoidable then proper measures for crossing it should be implemented. Presence of faults or potentially liquefiable materials would be of concern during the planning process.

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

6. 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.

7. Analysing 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.

8. 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.