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**Q no: 1:-**

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

**ANS:** Earthquakes are usually caused when rock underground suddenly breaks along a fault. This sudden release of energy causes the seismic waves that make the ground shake. When two blocks of rock or two plates are rubbing against each other, they stick a little. They don't just slide smoothly; the rocks catch on each other. The rocks are still pushing against each other, but not moving. After a while, the rocks break because of all the pressure that's built up. When the rocks break, the earthquake occurs. During the earthquake and afterward, the plates or blocks of rock start moving, and they continue to move until they get stuck again. The spot underground where the rock breaks is called the **focus** of the earthquake. The place right above the focus (on top of the ground) is called the **epicentre** of the earthquake.

There are three main types of fault, all of which may cause an interpolate earthquake: normal, reverse (thrust) and strike-slip. Normal and reverse faulting are examples of dip-slip, where the displacement along the fault is in the direction of dip and movement on them involves a vertical component. Normal faults occur mainly in areas where the crust is being extended such as a divergent boundary. Reverse faults occur in areas where the crust is being shortened such as at a convergent boundary. Strike-slip faults are steep structures where the two sides of the fault slip horizontally past each other; transform boundaries are a particular type of strike-slip fault. Many earthquakes are caused by movement on faults that have components of both dip-slip and strike-slip; this is known as oblique slip.

Reverse faults, particularly those along convergent plate boundaries are associated with the most powerful earthquakes, megathrust earthquakes.

**\*Consequences:**

Some of consequences are as under:

The Richter magnitude scale measures the amount of seismic energy released by an earthquake.

 The major earthquakes magnitude are 8 or more. Strike-slip faults, particularly continental transforms, can produce major earthquakes up to about magnitude 8. Earthquakes associated with normal faults are generally less than magnitude 7. For every unit increase in magnitude, there is a roughly thirtyfold increase in the energy released. For instance, an earthquake of magnitude 6.0 releases approximately 30 times more energy than a 5.0 magnitude earthquake and a 7.0 magnitude earthquake releases 900 times (30 × 30) more energy than a 5.0 magnitude of earthquake. An 8.6 magnitude earthquake releases the same amount of energy as 10,000 atomic bombs like those used in World War II.



**\*Difference between primary waves and secondary waves:**

**Primary waves :**

Primary waves, are the first waves to arrive at a seismograph. P waves are the fastest seismic waves and can move through solid, liquid or gas. They leave behind a trail of compressions and rarefactions on the medium they move through. P waves are also called Pressure waves for this reason. Certain animals, such as dogs, can feel the P waves much before an earthquake hits the crust (surface waves arrive). Humans can only feel the ramifications it has on the crust.

## **Secondary waves:**

Secondary waves, are the second waves to arrive during an earthquake. They are much slower than P waves and can travel only through solids. It is after studying the trajectory of S waves through the layers of earth, scientists were able to conclude that the earth’s outer core is liquid.

**Q no:2:-**

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

**ANS:**

 Geology has important role in selection of sites for dams and reservoir.

The important requirement here is that there should be no fear of leakage when the ground is under pressure with full head of water in the reservoir. Geological mapping on a large scale (say 10 cm to 9 km) may be made to collect and assemble the needed data. The location of the water table may also be investigated if necessary and the possible silting up of the site taken into consideration.

The rocks underneath any cover of superficial deposits may sometimes present some difficulties. These are due to the presence of highly permeable rocks which may affect the water-tightness of the reservoir. Limestone’s and such soluble rocks create the problems in this respect, since they are likely to develop solution channels that may carry away large quantity of water.

In such situations sometimes the large cavities in the limestone formation at the site may be filled in an expensive grouting programme by the injection of hot liquid asphalt through a series of holes drilled in the rock.

Gypsum beds are even more soluble than limestone. There are instances of water escaping through a gypsum layer which may get widened by solution. There are also instances of underground flow of water through a band of porous grit resulting in serious leakage. Leakages may also take place though fissures.

Rocks unlikely to allow passage of water include shale’s and slates, schist’s, gneisses and crystalline igneous rocks such as granite (except in conditions where well developed joint systems are present in them).

Percolation of water is possible through decomposed rocks (dolerite and laterite) and hence they should be avoided. From the above discussions we conclude that the main geological consideration in all dam sites is the stability of the rock in foundations.

**Geology in selection of sites for dams :**

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.

**Selection of sites is based on following basis**:

**Topographical** :

most suitable place must be chosen for construction.

Ideally it must be a narrow gorge or a small valley with enough catchment area available behind so that calculated amount of water can be easily stored in the reservoir created upstream.

**Location of spillway**:

All dam should have an adequate spillway for passing flood flows. If a river gorge is narrow, then there may not be sufficient spillway width available and a suitable location on the periphery of the reservoir has to be found to locate a spillway.

•**Possibility of river diversion during construction :**

The way, river can be diverted at a particular site for making way for construction of the dam

may affect the design of the dam and also the construction schedule.

**•Sedimentation possibilities** :

The average quantity of sediment carried by the river has to be known, as precisely as possible, which would

give an idea of the rate at which a proposed reservoir way get filled up.

**Technically:**

The site must be sound as possible: strong,

impermeable and stable. Strong rocks make the job of

designer easy. Impermeable sites ensure better storage

inventories. Site must be stable with respect to seismic

shocks slope failures around dam.

**Constructionally**:

The site should be far from the materials which will be used for the construction. Their non-availability will make the cost of project high.

**Human welfare:**

site selection should be done in such a way that it must

cause minimum damage to public in the destruction or failure.

**Q no: 3:-**

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

**ANS:** Mass wasting is further divided into two categories

 1: Fast movement

 2: Slow movement

**1:Fast movement:**

**\*Slump:**

A **slump** is a form of mass wasting that occurs when a coherent mass of loosely consolidated materials or a rock layer moves a short distance down a slope Movement is characterized by sliding along a concave-upward or planar surface. Causes of slumping include earthquake shocks, thorough wetting, freezing and thawing, undercutting, and loading of a slope.

Translational slumps occur when a detached landmass moves along a planar surface.

**\*Rock and debris fall:**

A **rock fall**  refers to quantities of rock falling freely from a cliff face. The term is also used for collapse of rock from roof or walls of mine or quarry workings. "A rockfall is a fragment of rock (a block) detached by sliding, toppling, or falling, that falls along a vertical or sub-vertical cliff, proceeds down slope by bouncing and flying along ballistic trajectories or by rolling on talus or debris slopes."

**\*Rock and debris slides :**

A **rockslide** is a type of landslides caused by rock failure in which part of the bleeding plane  of failure passes through compacted rock and material collapses *end masse* and not in individual blocks. Note that a rockslide is similar to an avalanche because they are both slides of debris that can bury a piece of land.

* **FLOW:**

A type of landslide in which the distribution of particle velocities resembles that of a viscous fluid is called a Flow.

**2:Slow movement :**

**\*Creep:**

**Creep** is the imperceptibly slow, steady, downward movement of slope-forming soil or rock. Movement is caused by shear stress sufficient to produce permanent deformation, but too small to produce shear failure.

**\*Solifluction:**

Solifluction is the name for the slow downhill flow of soil in arctic regions. It occurs slowly and is measured in millimetres or centimetres per year. It more or less uniformly affects the whole thickness of the soil rather than collecting in certain areas. It results from the complete waterlogging of sediment rather than short-lived episodes of saturation from storm runoff

**\*Permafrost:**

Permafrost is defined as ground (soil or rock and included ice or organic material) that remains at or below 0°C for at least two consecutive years. Lowland permafrost regions are traditionally divided into several zones based on estimated geographic continuity in the landscape.

**\*The protective measures of landslides :**

* Draining water from slopes.
* Revegetation with plants that have deep roots.
* Rock bolt can be used to stabilize the coherent masses.
* Retaining wall can catch debris or stabilize regolith.
* Do not put yard waste on the slope.
* Reinforcement of floor slab and external wall of existing buildings.
* Installation of drainage pipes for rainwater, slope drainage.

**Q no: 4:-**

**Differentiate fault, joint and fold?**

1. **What do the normal faults cause to the crust of the Earth?**
2. **Folds develop in which type of rock?**
3. **What is the effect of faulting on outcrop?**
4. **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.**

**ANS: \*Fault:**

**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. ... Energy release associated with rapid movement on active **faults** is the cause of most earthquakes.

**\*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.

**\*Fold:**

In response to compression force the strata may bend and buckle these are called folds.

1. **Causes of normal fault:**
* Small earthquakes
* Rock falls
* Mud flow
* Landslides
1. Folds develop in Sedimentary strata or Sedimentary material (Sedimentary rock).
2. **Effect of faulting on outcrop:**

Effect of faulting on outcrop is Changes in elevation, omission of some strata, repetition of some Strata.

Faulting is essentially a process of rupturing and displacement along the plane of rupture. Its effects may involve- changes in the elevation of the ground, omission of some strata where they are normally expected, repetition of some strata in a given direction and displacements and shifts in the continuity of the same rocks in certain regions.

1.

Point d: must be avoided to possible extend to be built on all three.

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**Q no: 5:-**

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

**ANS:**  There are two types of tunneling which are given below:

**1** : Hard Rock tunneling

**2:** soft rock tunneling

**Hard Rock tunneling :**

**Hard Rock**. **Tunneling** through **hard rock** almost always involves blasting. Workers use a scaffold, called a jumbo, to place explosives quickly and safely. The jumbo moves to the face of the **tunnel**, and drills mounted to the jumbo make several holes in the **rock**.

 **Soft rock tunneling :**

Soft-ground tunnels most commonly are used for urban services (subways, sewers, and other utilities) for which the need for quick access by passengers or maintenance staff favours a shallow depth. In many cities this means that the tunnels…

**Geological investigations for tunnels:**

**(a)Selection of Tunnel Route (Alignment):**

The first step for geological investigation here we must design horizontal and vertical alignment for road. There might be available many alternate alignments that could connect two points through a tunnel. However, the final choice would be greatly dependent on the geological constitution along and around different alternatives: the alignment having least geologically negative factors would be the obvious choice.

**(b) Selection of Excavation Method:**

Tunneling is a complicated process in any situation and involves huge costs which would multiply manifolds if proper planning is not exercised before starting the actual excavation. And the excavation methods are intimately linked with the type of rocks to be excavated. Choice of the right method will, therefore, be possible only when the nature of the rocks and the ground all along the alignment is fully known. This is one of the most important aim and object of geological investigations.

**(c) Selection of Design for the Tunnel**:

The ultimate dimensions and design parameters of a proposed tunnel are controlled, besides other factors, by geological constitution of the area along the alignment. Whether the tunnel is to be circular, D-Shaped, horse-shoe shaped or rectangular or combination of one or more of these outlines, is more often dictated by the geology of the alignment than by any other single factor. D-shape or horse-shoe shape may be conveniently adopted but these shapes would be practically unsuitable in soft ground or even in weak rocks with unequal lateral pressure. In those cases circular outline may be the first choice.

**(d) Assessment of Cost and Stability**:

These aspects of the tunneling projects are also closely interlinked with the first three considerations. Since geological investigations will determine the line of actual excavation, the method of excavation and the dimensions of excavation as also the supporting system (lining) of the excavation, all estimates about the cost of the project would depend on the geological details.

**(e) Assessment of Environmental Hazards**:

The process of tunneling, whether through rocks or through soft ground, and for whatsoever purpose, involves disturbing the environment of an area in more than one way. The tunneling methods might involve vibrations induced through blasting or ground cutting and drilling, producing abnormal quantities of dust and last but not the least, interference with water supply system of the nearby areas.

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