IQRA NATIONAL UNIVERSITY PESHAWAR

DEPARTMENT OF CIVIL ENGINEERING

SUBJECT: ENGINEERING GEOLOGY

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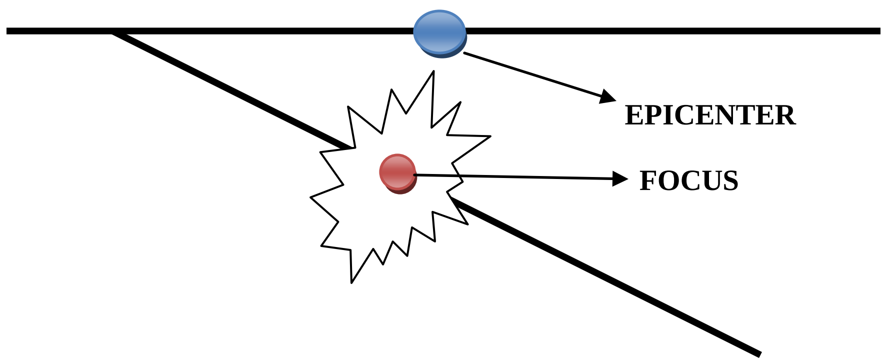
ID: 7754 SECTION: B

Q.NO (01) PART A

ANSWER

FOCUS: The Focus or hypocenter is the point within the earth where an earthquake rupture starts. The epicenter is the point directly above it at the surface of the Earth.



EPICENTER: The point on the earth's surface directly above the origin of an earthquake. An epicenter is also the place that has the highest level of an activity. The epicenter is the projection to the surface, perpendicular to the hypocenter that reflects the intensity of an earthquake, a product of the liberation of tensions in the failure or weakness area in the Earth's crust.

EARTHQUAKE INTENSITY: Intensity is a measure of an earthquake determined from the observed effects, especially damage. For a given earthquake, intensity normally decreases with distance from the Epicenter. The observations can then be compiled to make macro-seismic maps showing lines of equal intensity.

SEISMOGRAM: A seismogram is a record written by a seismograph in response to ground motions produced by an earthquake, explosion, or other ground-motion sources.

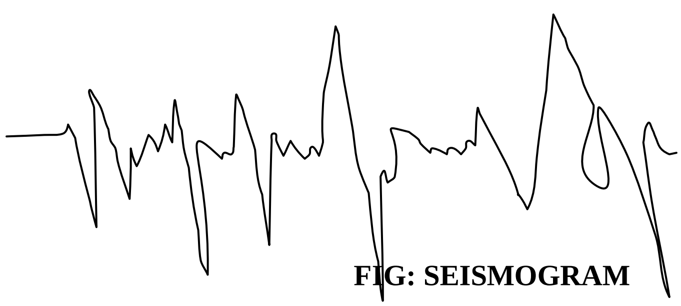


FIG: SEISMOGRAM

SEISMOGRAPH: A seismograph is the device that scientists use to measure earthquakes. The goal of a seismograph is to accurately record the motion of the ground during a quake. If you live in a city, you may have noticed that buildings sometimes shake when a big truck or a subway train rolls by. Good seismographs are therefore isolated and connected to bedrock to prevent this sort of "data pollution."

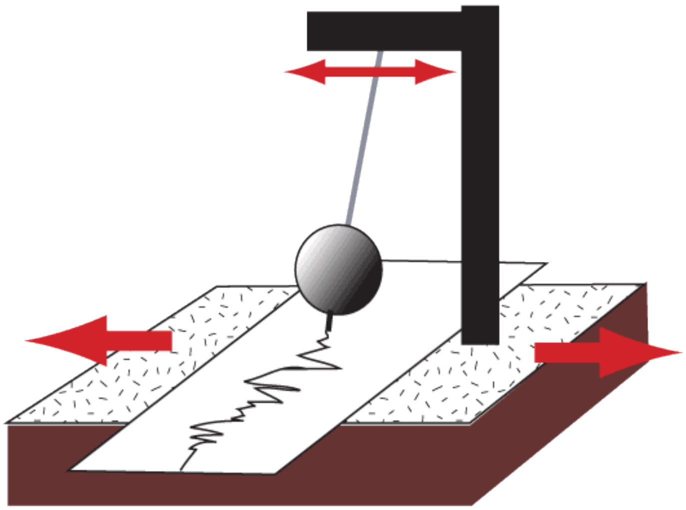


FIG: SEISMOGRAPH

Q.NO (01) PART B

ANSWER

CLASSIFICATION OF EARTH QUAKE DUE TO MODE OF ORIGIN

Earthquake Due To Volcanic Causes: Most earthquakes directly beneath a volcano are caused by the movement of magma. The magma exerts pressure on the rocks until it cracks the rock. Then the magma squirts into the crack and starts building pressure again. Every time the rock cracks it makes a small earthquake.

Earthquake Due To Surface Causes: At the Earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground. Sometimes, they cause tsunamis, which may lead to loss of life and destruction of property.

Earthquake Due To Tectonic Causes: Tectonic earthquakes occur at plate tectonic boundaries. Tectonic plates are constantly moving slowly, but sometimes friction between them causes them lock together and become unable to move. The waves of released energy move through the Earth's crust and cause the shaking we feel at an earthquake site.

Q.NO (01) PART C

ANSWER

S-Waves:

- The S waves are the second wave to reach a seismic station measuring a disturbance.
- S waves travel significantly slower, between 1 and 8 km per second as compared to P waves.

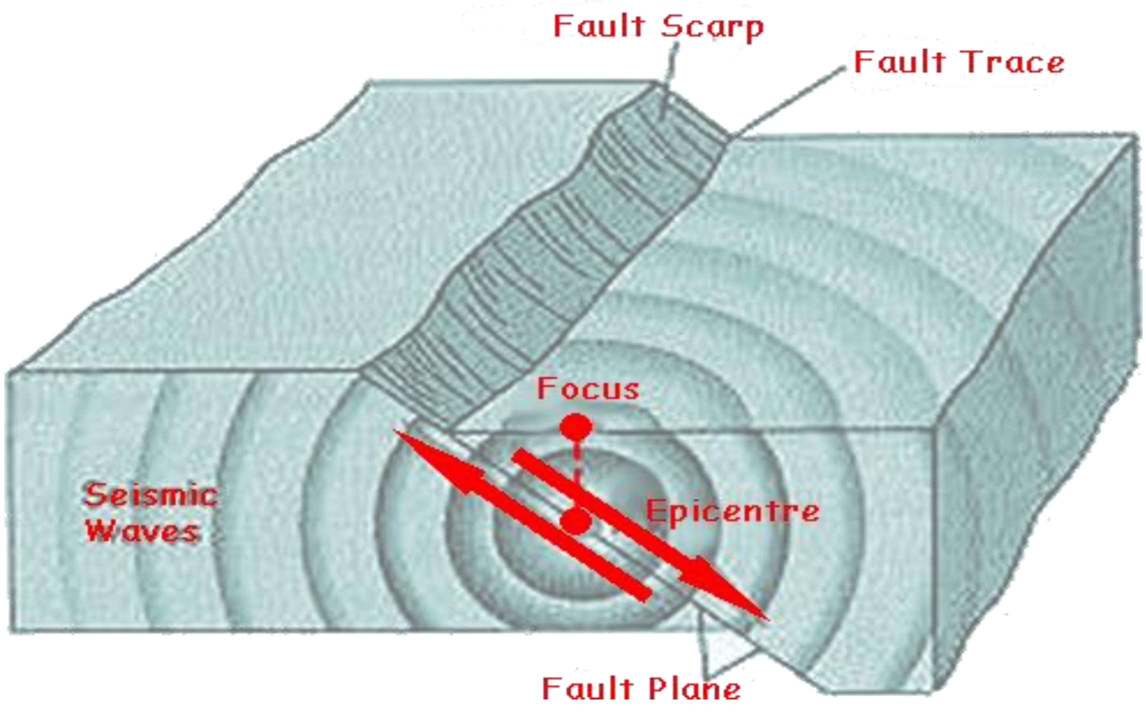
- S waves are transverse waves, which mean they vibrate up and down, perpendicular to the motion of the wave as they travel.
- In an S wave, particles travel up and down and the wave moves forward, like the image of a sine wave.
- S waves are generally larger than P waves, causing much of the damage in an earthquake.

P-Waves:

- P waves travel faster than S waves, and are the first waves recorded by a seismograph in the event of a disturbance.
- P waves travel at speeds between 1 and 14 km per second.
- Primary waves are made up of compression waves, also known as push-pull waves. The individual waves, therefore, push against one another, causing a constant parallel, straight motion.
- Because of their wave movement, P waves travel through any kind of material, whether it is a solid, liquid or gas.
- The major differences between P waves and S waves include wave speeds, wave types, travel capabilities, and wave sizes.
- Primary waves travel faster, move in a push-pull pattern, travel through solids, liquids and gases, and cause less damage due to their smaller size

L-Waves:

- The L waves travel along the surface of the earth from the point directly above the quake or epicenter.
- L-waves are shear waves where the shearing (back and forth) motion, is confined to a horizontal plane at the Earth's surface.



- These travel through the 'crust of the Earth' (lithosphere)
- The Love wave is a result of the interference of many shear waves guided by an elastic layer, which is welded to an elastic half space on one side while bordering a vacuum on the other side.

Q.NO (02) PART A
ANSWER

MODIFIED MERCALLI SCALE
The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at that place.

The lower numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.

The Modified Mercalli scale is designed to describe the effects of an earthquake, at a given place, on natural features, on industrial installations and on human beings. The intensity differs from the magnitude which is related to the energy released by an earthquake.

Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest,especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	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, walls. Heavy furniture overturned.
IX	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.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Q.NO (02) PART B
ANSWER

VOLCANO: A volcano is an opening in the earth's crust through which lava, volcanic ash, and gases escape. Volcanic eruptions are partly driven by pressure from dissolved gas, much as escaping gases force the cork out of a bottle of champagne. Beneath a volcano, liquid magma containing dissolved gases rises through cracks in the Earth's crust.

VOLCANIC CONE
Volcanic cones are among the simplest volcanic landforms. They are built by eject from a volcanic vent, piling up around the vent in the shape of a cone with a central crater. Volcanic cones are of different types, depending upon the nature and size of the fragments ejected during the eruption

A volcanic cone is a triangle-shaped hill formed as material from volcanic eruptions piles up around the volcanic vent, or opening in Earth's crust. Most volcanic cones have one volcanic crater, or central depression, at the top. They are probably the most familiar type of volcanic mountain.

MAJOR TYPES OF VOLCANO

Composite cones: Composite cones are some of the most easily recognizable and imposing volcanic mountains, with sloping peaks rising several thousand meters above the landscape.

Cinder cones: Cinder cones, sometimes called scoria cones or pyroclastic cones, are the most common types of volcanic cones. They form after violent eruptions blow lava fragments into the air, which then solidify and fall as cinders around the volcanic vent. Usually the size of gravel, these cinders are filled with many tiny bubbles trapped in the lava as it solidifies. Cinder cones stand at heights of tens of meters to hundreds of meters.

Spatter Cones: Volcanoes often eject small amounts of gaseous lava blobs into the air. These lava blobs, called spatter, are heavy and viscous. Viscosity refers to a substance's resistance to flow. In this case, it refers to the spatter's thickness. The viscosity of spatter means it often does not have time to cool before hitting the ground.

Tuff Cones: Unlike spatter cones that form from lava fountaining, tuff cones form from the interaction between rising magma and bodies of water. Tuff cones are sometimes called ash cones.

When heated rapidly by lava, water flashes to steam and expands violently, fragmenting huge amounts of lava into plumes of very fine grains of ash. This ash falls around the volcanic vent, creating an ash cone. Over time, the ash weathers into a rock known as tuff.

Shield cones: Shield cones were named by Icelandic people because the cone's shape reminded them of a warriors shield laid down. Shield cones form from hot, runny lava that is erupted from the the volcano through its summit and the many side vents and fissures throughout the volcano's flanks (Sides). Shield cones are low, very broad, and gently sloping volcanoes.

Q.NO (03) PART A
ANSWER

GROUNDWATER

Groundwater is water that exists in the pore spaces and fractures in rocks and sediments beneath the Earth's surface. It originates as rainfall or snow, and then moves through the soil and rock into the groundwater system, where it eventually makes its way back to the surface streams, lakes, or oceans.

- Groundwater makes up about 1% of the water on the Earth (most water is in oceans)
- But, groundwater makes up to 35 times the amount of water in lakes and streams.
- Groundwater occurs everywhere beneath the Earth's surface, but is usually restricted to depth less than about 750 meters.
- The volume of groundwater is equivalent to a 55-meter thick layer spread out over the entire surface of the Earth

ORIGIN OF GROUNDWATER

The origin of groundwater is primarily one of the following:

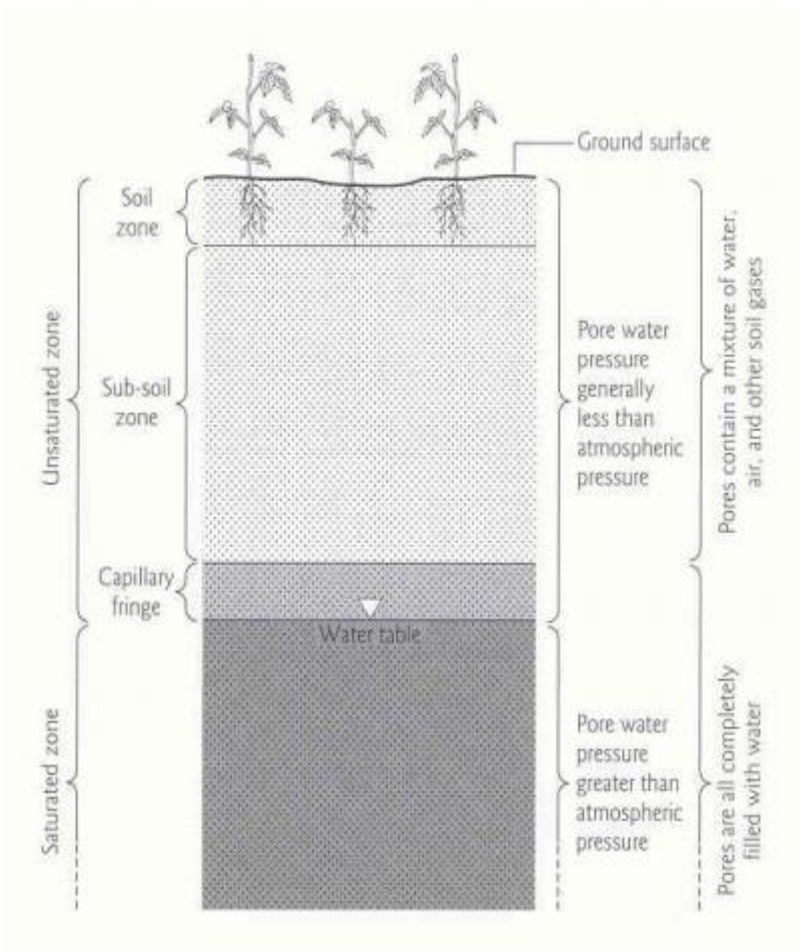
- Groundwater derived from rainfall and infiltration within the normal hydrological cycle. This kind of water is called **meteoric water**. The name implies recent contact with the atmosphere.
- Groundwater encountered at great depths in sedimentary rocks as a result of water having been trapped in marine sediments at the time of their deposition. This type of groundwater is referred

to as **connate waters.** These waters are normally saline. It is accepted that connate water is derived mainly or entirely from entrapped sea water as original sea water has moved from its original place. Some trapped water may be brackish.

- **Fossil water** if fresh may be originated from the fact of climate change phenomenon, i.e., some areas used to have wet weather and the aquifers of that area were recharged and then the weather of that area becomes dry.

THE OCCURRENCE OF SUBSURFACE WATER

The subsurface occurrence of groundwater may be divided into zones of aeration and saturation. The zone of aeration consists of interstices occupied partially by water and partially by air. In the zone of saturation all interstices are filled with water, under hydrostatic pressure. One most of the land masses of the earth, a single zone of aeration overlies a single zone of saturation and extends upward to the ground surface.



A schematic cross-section showing the typical distribution of subsurface waters in a simple "unconfined" aquifer setting, highlighting the three common subdivisions of the unsaturated zone

Most groundwater originates as meteoric water from precipitation in the form of rain or snow. If it is not lost by evaporation, transpiration or to stream runoff, water from these sources may infiltrate into the ground. Initial amounts of water from precipitation onto dry soil are held very tightly as a film on the surfaces and in the micro pores of soil particles in a belt of soil mixture. At intermediate levels, films of water cover the solid particles, but air is still present in the voids of the soil. This region is called unsaturated zone or zone of aeration, and the water present is vadose water. At lower depths and in presence of adequate amounts of water, all voids are filled to produce a zone of saturation, the upper level of which is the water table. Water present in a zone of saturation is called groundwater.

Q.NO (03) PART B
ANSWER

WELL
A well is an excavation or structure created in the ground by digging, driving, or drilling to access liquid resources, usually water. The oldest and most common kind of well is a water well, to access groundwater in underground aquifers. The well water is drawn up by a pump, or using containers, such as buckets, that are raised mechanically or by hand. Water can also be injected back into the aquifer through the well.

TYPES OF WELLS
Digging a well by hand is becoming outdated today as automated drilling methods replace manual-labor methods. Modern wells are more often drilled by a truck-mounted drill rig. Still, there are many ways to put in a well — here are some of the common methods.

DUG WELLS
Hacking at the ground with a pick and shovel is one way to dig a well. If the ground is soft and the water table is shallow, then dug wells can work. Historically, dug wells were excavated by hand shovel to below the water table until incoming water exceeded the digger's bailing rate. The well was lined with stones, brick, tile, or other material to prevent collapse, and was covered with a cap of wood, stone, or concrete. They cannot be dug much deeper than the water table.

DRIVEN WELLS
Driven wells are still common today. They are built by driving a small-diameter pipe into soft earth, such as sand or gravel. A screen is usually attached to the bottom of the pipe to filter out sand and other particles.

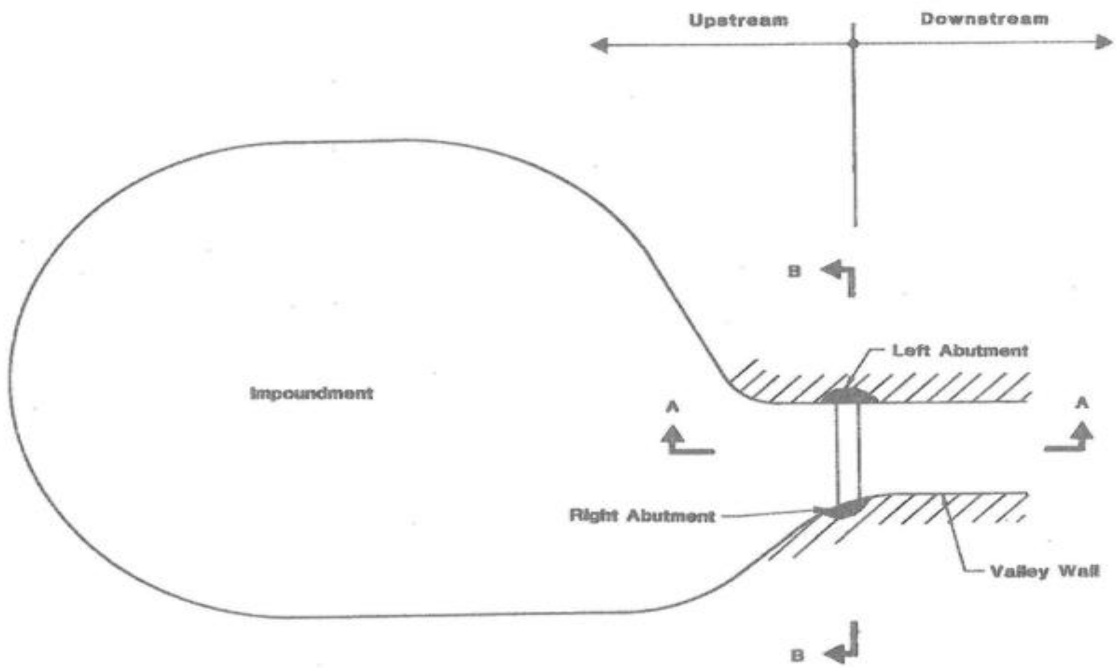
DRILLED WELLS
Most modern wells are drilled, which requires a fairly complicated and expensive drill rig. Drill rigs are often mounted on big trucks. They use rotary drill bits that chew away at the rock, percussion bits that smash the rock, or, if the ground is soft, large auger bits. Drilled wells can be drilled more than 1,000 feet deep. Often a pump is placed in the well at some depth to push the water up to the surface.

Q.NO (04) PART A
ANSWER

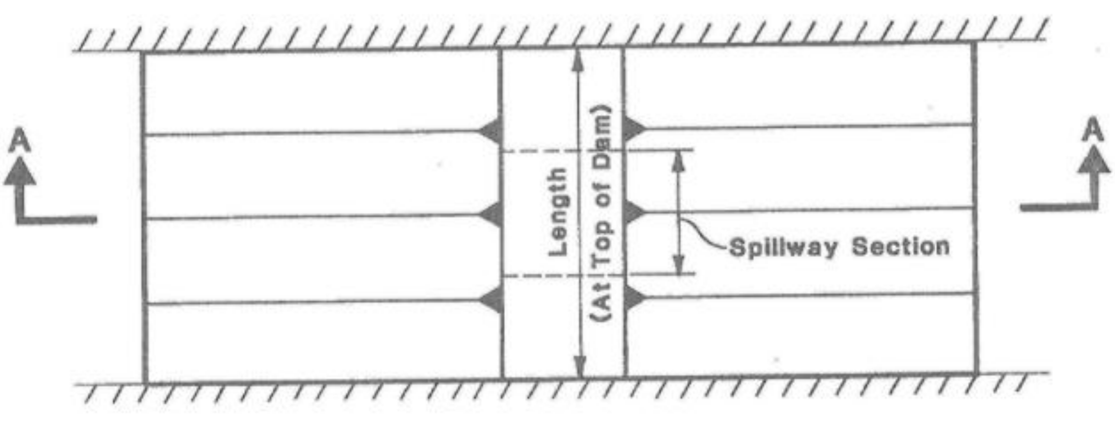
The following is a list of terms and their definitions that are frequently used when discussing the physical characteristics of dams.
ABUTMENT: The part of the valley side against which the dam is constructed.
BASE WIDTH: The width of the dam measured along the dam/foundation interface.
BREACH: An opening or a breakthrough of a dam sometimes caused by rapid erosion of a section of earth embankment by water.
CONDUIT: A closed channel to convey the discharge through or under a dam. Usually pipes constructed of concrete or steel.
CORE (IMPERVIOUS CORE) (IMPERVIOUS ZONE): A zone of material of low permeability in an embankment dam, hence the terms central core, inclined core, puddle clay core, and rolled clay core.
CREST LENGTH: The developed length of the top of the dam. This includes the length of the spillway, powerhouse, navigation lock, fish pass, etc.

CREST OF DAM: The term crest of dam is often used when top of spillway and top of dam should be used for referring to the overflow section and dam proper, respectively.
CUTOFF: An impervious construction by means of which seepage is reduced or prevented from passing through foundation material.
CUTOFF WALL: A wall of impervious material, e.g., concrete, wood pilings, steel sheet piling, built into the foundation to reduce seepage under the dam.
DRAINAGE LAYER OR BLANKET: A layer of pervious material placed directly over the foundation material or downstream slope to facilitate seepage drainage of the embankment.
EMBANKMENT: Fill material, usually earth or rock, placed with sloping sides.
EMERGENCY ACTION PLAN: A predetermined plan of action to be taken to reduce the potential for property damage and loss of lives in an area affected by a dam break.
FACE: With reference to a structure, the external surface that limits the structure, e.g., the face of the wall or dam.
FLASHBOARDS: Lengths of timber, concrete, or steel placed on the crest of a spillway to raise the operating water level.
FOUNDATION OF DAM: The natural material on which the dam structure is placed.
FREEBOARD: The vertical distance from the water surface to the lowest elevation at which water would flow over the dam at a section not designed to be overflowed.
GATE: In general, a device in which a leaf or member is moved across the waterway from an external position to control or stop the flow.
HEEL OF DAM: The junction of the upstream face of a gravity or arch dam with the foundation surface. In the case of an embankment dam the junction is referred to as the upstream toe of the dam.
INTAKE: Any structure in a reservoir, dam, or river through which water can be drawn into an outlet pipe, flume, etc.
LOW LEVEL OUTLET (BOTTOM OUTLET): An opening at a low level from the reservoir generally used for emptying the impoundment.
OUTLET: An opening through which water can be freely discharged for a particular purpose from a reservoir.
PERVIOUS ZONE: A part of the cross section of an embankment dam comprising material of high permeability.
RIPRAP: A layer of large un-coursed stones, broken rock, or precast blocks placed in random fashion on the upstream slope of an embankment dam, on a reservoir shore, or on the sides of a channel as a protection against wave and ice action.
SEEPAGE COLLAR: A projecting collar usually of concrete or steel built around the outside of a pipe, tunnel, or conduit, under an embankment dam, to lengthen the seepage path along the outer surface of the conduit.
SPILLWAY: A structure over or through which flood flows are discharged. If the flow is controlled by gates, it is considered a controlled spillway; if the elevation of the spillway crest is the only control, it is considered an uncontrolled spillway.
TOE OF DAM: The junction of the downstream face of a dam with the natural ground surface. This is also referred to as the downstream toe. For an embankment dam the junction of the upstream face with ground surface is called the upstream toe.
TOP OF DAM: The elevation of the upper most surface of a dam, usually a road or walkway, excluding any parapet wall, railings, etc.
TOP THICKNESS (TOP WIDTH): The thickness or width of a dam at the top of the dam. In general, the term thickness is used for gravity and arch dams, width is used for other dams.
TRAINING WALL: A wall built to confine or guide the flow of water.
TRASH RACK: A screen comprising metal or reinforced concrete bars located in the waterway at an intake so as to prevent the ingress of floating or submerged debris.

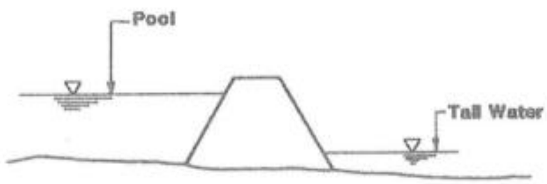
BASIC NOMENCLATURE OF A DAM



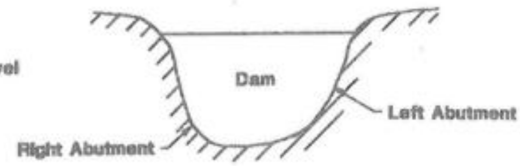
DAM GEOMETRY



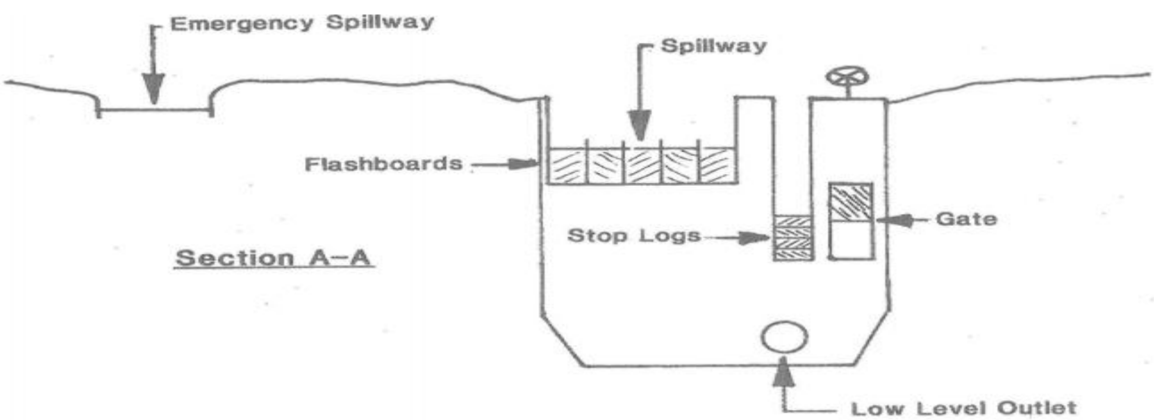
PLAN VIEW



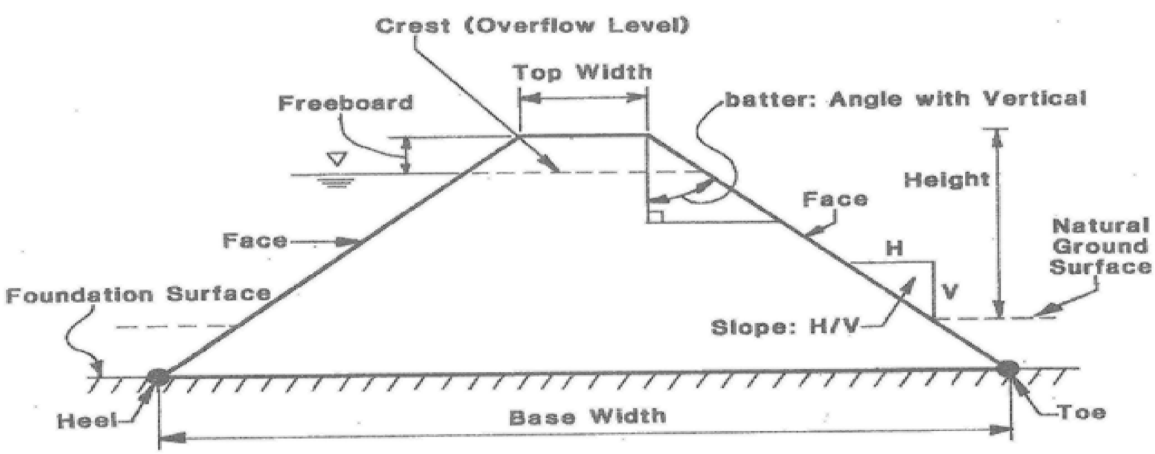
Section A-A



Section B-B



Operating Elements



SECTION A-A

Q.NO (04) PART B
ANSWER

GEOTECHNICAL INVESTIGATION FOR RESERVOIR

The most important factor influencing feasibility of proposed reservoir site is generally the location of the dam.

- After that, consideration must be given to the run-off characteristics of the catchment area, the water tightness of the proposed reservoir basin, the stability of the valley sides, the likely rate of sedimentation in the new reservoir, the quality of the water and, if it is to be a very large reservoir, the possibility of associated seismic activity.
- Topography: The area should be a wide natural valley preferably ending in a narrow gorge where a barrier (dam) could be placed.
- Initial estimates of storage capacity can be made from topographic maps or aerial photographs, more accurate information being obtained, where necessary, from subsequent surveying.
- Catchment areas and drainage densities can also be determined from maps and air photos.
- Reservoir volume can be estimated by plan-metering areas upstream of the dam site for successive contours up to proposed top water level

GROUNDWATER CONDITION

- Amount of leakage of water from the reservoir is controlled by the depth of water table.
- If the water table is so near the ground surface, the water level in reservoir doesn't rise above it, no serious loss by leakage will occur.
- On the other hand if water table lies deep below the ground surface, the water table lies deep below the ground surface, the water level in the reservoir will stand above it and leakage will occur, the amount of which will depend on the permeability of the earth material it rests upon.

PERMEABILITY

- During geological investigation, it is necessary to locate the highly permeable layers present in the reservoir area.
- The rocks highly fissured, intensely jointed, faulted or have solution channels cause serious leakage from the reservoir
- Generally leakage will be more in rock dipping downstream than upstream
- In some cases ancient channels buried below the present valley floor, called buried valleys often provide passage for profuse leakage of reservoir water.
- Sedimentation in Reservoir: The amount of silt produced and supplied to the rivers depends mainly upon the litho-logical character and topography of the catchment area.
- The rivers flowing over the soft rocks and high gradient areas carry greater amount of silt.
- Reservoirs built on rivers which carry large amount of sediment, may silt up very soon and its water storage capacity may be reduced considerably.

GEOLOGY

- The rocks exposed in the reservoir rim must be resistant to solution, erosion and free of voids to stop leakage.
- If some potential leakage zones are present, they should be delineated.
- Highly jointed rocks should be investigated for joint intensity and spacing which will help in assessing the grouting.

- Faults if present should be delineated since they require treatment which may be expensive.
- Faults may be a passageway for water leakage as well as vulnerable or liable for earthquake effect.
- Movement on fault may initiate due to weight of water in the reservoir.
- If sand and gravel or other permeable bed are in the surface or vicinity of the proposed site, they may serious effect the efficiency of reservoir.
- Valley sections in competent, hard resistant rocks like granite, quartzite, gneiss provide excellent sites.

Q.NO (05) PART A

ANSWER

LANDSLIDE

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity. The term "landslide" encompasses five modes of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth). Debris flows (commonly referred to as mudflows or mudslides) and rock falls are examples of common landslide types.

LANDSLIDE PREVENTION

Landslides pose a recurrent hazard to human life and livelihood in most parts of the world, especially in some regions that have experienced rapid population and economic growth. Hazards are mitigated mainly through precautionary means

- For instance, by restricting or even removing populations from areas with a history of landslides,
- By restricting certain types of land use where slope stability is in question
- By installing early warning systems based on the monitoring of ground conditions such as strain in rocks and soils
- Slope displacement, and groundwater levels.

There are also various direct methods of preventing landslides; these include:

- Modifying slope geometry,
- Using chemical agents to reinforce slope material
- Installing structures such as piles and retaining walls,
- Grouting rock joints and fissures,
- Diverting debris pathways, and
- Rerouting surface and underwater drainage.

Such direct methods are constrained by cost, landslide magnitude and frequency, and the size of human settlements at risk.

Q.NO (05) PART B
ANSWER
GLACIERS

Glaciers are made up of fallen snow that, over many years, compresses into large, thickened ice masses. Glaciers form when snow remains in one location long enough to transform into ice. What makes glaciers unique is their ability to flow. Due to sheer mass, glaciers flow like very slow rivers. Some glaciers are as small as football fields, while others grow to be dozens or even hundreds of kilometers long.

Typically, glaciers exist and may even form in areas where:

- Mean annual temperatures are close to the freezing point
- Winter precipitation produces significant accumulations of snow
- Temperatures throughout the rest of the year do not result in the complete loss of the previous winter's snow accumulation

Over multiple decades this continuing accumulation of snow results in the presence of a large enough mass of snow for the metamorphism from snow to glacier ice process to begin. Glaciers are classified by their size (i.e. ice sheet, ice cap, valley glacier, cirque glacier), location, and thermal regime (i.e., polar vs. temperate). Glaciers are sensitive indicators of changing climate.

MOVEMENT OF GLACIERS

Over multiple decades this continuing accumulation of snow results in the presence of a large enough mass of snow for the metamorphism from snow to glacier ice process to begin. Glaciers are classified by their size (i.e. ice sheet, ice cap, valley glacier, cirque glacier), location, and thermal regime (i.e., polar vs. temperate). Glaciers are sensitive indicators of changing climate.

A glacier might look like a solid block of ice, but it is actually moving very slowly. The glacier moves because pressure from the weight of the overlying ice causes it to deform and flow. Melt water at the bottom of the glacier helps it to glide over the landscape.

The edges and upper layer of the glacier is not under as much pressure. These sections are more rigid and prone to cracking. The cracks are called crevasses. Lots of crevasses form when the ice flows over large bumps or around a bend in a valley.

Glaciers move very slowly. Most of the time they only advance a few centimeters to a few meters each day. Occasionally a glacier speeds up. This is called surging. A surging glacier can advance tens or even hundreds of meters a day.