Student ID: 13727 **Program:** B.Tech (civil).
Semester: 6TH **Exam:** Mid Term.
Subject: Engineering Geology.
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Question# 01: Why is geology essential when it comes to the domain of civil engineering? Analyze the involvement of Geology in all the aspects of a construction project?

Ans: Importance of geology in civil engineering:

Geology is the study of earth, the materials of which it is made, the structure of those materials and the effects of the natural forces acting upon them and is important to civil engineering because all work performed by civil engineers involves earth and its features. Fundamental understanding of geology is so important that it is a requirement in university-level civil engineering programs. For a civil engineering project to be successful, the engineers must understand the land upon which the project rests. Geologists study the land to determine whether it is stable enough to support the proposed project. They also study water patterns to determine if a particular site is prone to flooding. Some civil engineers use geologists to examine rocks for important metals, oil, natural gas and ground water.

Involvement of Geology in the aspects of a construction project: The branch of engineering that deals with the planning, construction and maintenance of these major structures is known as civil engineering. This unit summarizes some geological aspects of civil engineering. Examples of facilities that require considerable alteration of Earth's surface are highways, railways, bridges, dams and pipelines. The geology of an area dictates the location and nature of any civil engineering structures.

(i) Dam: Geological investigations of a site proposed for construction of a dam must be complete and detailed. Features such as rock-types, geological structures, weathering, fractures and fissures must all be considered. The main considerations are that the material on which the dam rests must be able to carry the weight of the structure without failing. The geology upon which the dam is built must also be impervious to water. A dam is built across the river and width of river should be minimum as well as possible or narrow river valley cast that is reduce the cost of dam, primarily to store the water. The whole ideas of build the dam will become useless if the foundation on which the dam is built is the porous or permeable. In such a place quite an appreciable amount of water is leakage in to the rock below the foundation, and reduces the capacity of dam.

Failure of a dam can be due to many factors including:

- Earthquakes
- A sudden drop in water level
- Inadequate protection of the reservoir side of the dam from wave action
- Insufficient spillway capacity, so that water flows over the whole of the dam surface, with consequent erosion

(ii) Reservoir: A natural or artificial pond or lake used for the storage and regulation of water is called reservoir. A dam is also called a reservoir. In reservoir all consideration and safety precaution taken in to account as well as dam

(iii)Tunnel: Tunnels are underground passage. Therefore to pass the traffic or to pass the water. The design, construction, and maintenance of tunnel will be depending on a full knowledge of the situation of the

ground water and quantity of water. Knowledge of rock geology, rock formation around the tunnel is very important.

(iv) Highway: Road and highways are very important project for any country, their planning, designing, construction, and maintenance is among the major duties of civil engineer the world over. For any civil engineering project geological investigation play important role. These geological factors on the alignment and stability of roads.

- Topography
- Lithology
- Geological character
- Weathering
- Ground water condition

The main object of geological investigation for any civil engineering project.

- Investigation of geological structure of the related area.
- Investigation of earth surface.
- Ground water condition of that particular area.
- Seismic condition of that region and study the last 60 years seismic detail.
- Litho logy of the area

Question # 02:

a) Give some possible reasons of post-volcanic changes.

Ans: Reason of Post Volcanic Changes:

- The gases with which the magma is charged are slowly dissipated, lava flows often remain hot and steaming for many years.
- These gases attack the components of the rock and deposit new minerals in cavities and fissures.
- Even before these "post-volcanic" processes have ceased,
- Atmospheric decomposition or weathering begins as the mineral components of volcanic and igneous rocks are not stable under surface atmospheric conditions.
- Rain, frost, carbonic acid, oxygen and other agents operate continuously, and do not cease until the whole mass has crumbled down and most of its ingredients have been resolved into new products or carried away in aqueous solution.

b) Explain how the amount of SiO2 ultimately effects the composition of igneous rocks?

Ans: the amount of SiO2 ultimately effect the composition of igneous rocks which shown in table.

Rock composition	Amount of SiO2 (%)	Minerals
acid	65	quartz, orthoclase, Na-plagioclase, muscovite, biotite (±hornblende)
intermediate	55–65	plagioclase, biotite, hornblende, quartz, orthoclase (±augite)
basic	45–55	Ca-plagioclase, augite (±olivine, ±hornblende)
ultrabasic	45	Ca-plagioclase, olivine (±augite)

This terminology is based on the onetime idea that rocks with a high % SiO_2 were precipitated from waters with a high concentration of hyrdosilicic acid H_4SiO_4. Although we now know this is not true, the acid/base terminology is well entrenched in the literature.

Question# 3: Why does weathering occur? Make a comparative analysis of different forms of weathering.

Ans: weathering: Simply, it is due to the response of Earth material to a changing environment. For example imagine an intrusive igneous rock in Earth's subsurface. After the uplift and erosion since many years, the rock may be exposed at the surface. Igneous rocks are formed at high temperature and pressure. In response to the change environment (Temperature and Pressure), the rock change gradually. This transformation is what we call as Weathering.

There are 3 types of weathering

1. Physical weathering.
2. Chemical weathering.
3. Biological weathering.

1) Physical weathering:

- Physical weathering is the class of processes that causes the disintegration of rocks without chemical change.
- The primary process in physical weathering is abrasion,

The process by which clasts and other particles are reduced in size.

- A soil derived from a single rock type can often be deficient in one or more minerals for good fertility.
- A soil weathered from a mix of rock types (as in glacial, alluvial sediments) often makes more fertile soil.
- However, chemical and physical weathering often go hand in hand.
- Physical weathering can occur due to temperature, pressure, frost etc.
- Physical weathering is also called mechanical weathering, disaggregation.

There are four types of physical weathering, Thermal stress weathering, Frost weathering, Pressure Release/Unloading and Salt-Crystal Growth.

A. Thermal–Stress Weathering:

- Thermal stress weathering, also called as Insolation Weathering.
- It results from expansion and contraction of rock, caused by temperature changes (Principal Driver). Daily changes by 30^o to 50^o
- Thermal stress weathering comprises two main types, Thermal Shock, differential stresses Thermal Fatigue, cyclic phenomenon
- Thermal stress weathering is an important mechanism in deserts,
- There is a large diurnal temperature range, Hot in the day and cold at night.

B. Frost Weathering:

- Frost weathering, frost wedging, ice wedging or cryofracturing where ice is present.
- These processes include Frost Shattering, Frost Wedging Freeze and Thaw Weathering
- Severe frost shattering produces huge piles of rock fragments called Scree, at the foothills.

- Similar like soil expands due to capillary action and formation of ice, Rock is weakened which break up for 10% ice expansion.
- **Driving agents:**

  Moisture, Temperature, fluctuating above and below and freezing point is Alpine; Switzerland, Italy, France, Germany

  A frost action in chalk is a classical example to exhibit break up on repeated freezing and thawing.

C. Pressure Release/Unloading:

- Pressure release, Unloading, overlying materials are removed by erosion or other process,

It causes underlying rocks to Expand and Fracture parallel to the surface.

- Intrusive igneous rocks (e.g. granite) are formed deep beneath the Earth's surface.
- They are under tremendous pressure because of the overlying rock material.
- These rocks if exposed, the pressure on them will release.
- The outer parts of the rocks then tend to expand.
- The expansion sets up stresses which cause fractures parallel to the rock surface to form.
- Over time, sheets of rock break away from the exposed rocks along the fractures,
- A process known as Exfoliation, Sheeting. Fractures are closely spaced Earth's surface.

D. Salt-Crystal Growth:

- Salt crystallization, otherwise known as haloclasty, causes disintegration of rocks, when saline solutions seep into cracks and joints in the rocks and Evaporate, leaving salt crystals behind. These salt crystals expand as they are heated up, exerting pressure on the confining rock.
- Salt crystallization may also take place when solutions decompose rocks For example, (limestone and chalk) to form salt solutions of sodium sulfate or sodium carbonate, The moisture evaporates to form their respective salt crystals.
- The salts which have proved most effective in disintegrating rocks are Sodium Sulfate, Magnesium Sulfate, and Calcium Chloride.
- Salts can expand up to three times or even more.

2) Chemical Weathering:

- Chemical weathering changes the composition of rocks, Often transforming them when water interacts with minerals to create various chemical reactions.
- Complex processes that break down components and internal structures of minerals, Converting constituents to new minerals Releasing to surrounding environment
- Chemical weathering is a gradual and ongoing process as the mineralogy of the rock adjusts to the near surface environment. New or secondary Stable minerals develop from the original minerals of the rock.
- For chemical weathering, two processes are important Oxidation, Electron loss for stability Hydrolysis, chemical bond cleavage by water addition

There are three types of chemical weathering, oxidation, Dissolution and carbonation and Hydration and Hydrolysis.

A. Oxidation:

- Oxidation takes place when oxygen reacts with earth materials. Oxygen dissolved in water combines with atoms of metallic elements abundant in silicate minerals. Attacking metals in the soil, oxidation causes them to rust leaving the soil a brownish red to red color. When oxygen combines with iron, the reddish iron oxide hematite (Fe_2O_3) is formed:

  $4Fe^{+3} + 3O_2 \rightarrow 2Fe_2O_3$

- This process is better known as Rusting, Though it is distinct from the rusting of metallic iron.

B. Dissolution and Carbonation

- Rainfall is acidic, Atmospheric carbon dioxide dissolves in the rainwater producing weak carbonic acid. Acid rain occurs when gases such as sulfur dioxide and nitrogen oxides are present in the atmosphere.
- These oxides react in the rain water to produce stronger acids.
- Sulfur dioxide, SO2, comes from volcanic eruptions or from fossil fuels, It can become sulfuric acid H2SO4 within rainwater, Which can cause solution weathering to the rocks on which it falls.
- Carbonation is the most well-known solution weathering processes, The process in which atmospheric carbon dioxide leads to solution weathering Carbonation occurs on rocks which contain calcium carbonate,
- For example, limestone and chalk
- This process speeds up with a decrease in temperature,

C. Hydration and Hydrolysis:

- **Hydration:** Mineral hydration is a form of chemical weathering, It involves the rigid attachment of H+ and OH− ions to the atoms and molecules of a mineral
- When rock minerals take up water, The increased volume creates physical stresses within the rock For example iron oxides are converted to iron hydroxides and The hydration of anhydrite forms gypsum.
- **Hydrolysis**: Hydrolysis is a chemical weathering process affecting silicate and carbonate minerals. In such reactions, pure water ionizes slightly and reacts with silicate minerals
  $Mg2SiO4 + 4 H+ + 4 OH− 2 Mg2+ + 4 OH− + H4SiO4$
- This reaction theoretically results in complete dissolution of the original mineral, If enough water is available to drive the reaction Carbon dioxide, dissolves readily in water forming a weak acid and H + donor
  $Mg2SiO4 + 4 CO2 + 4 H2O 2 Mg2+ + 4 HCO3− + H4SiO4.$

3) Biological weathering :

- Biological weathering only refers to weathering caused by organisms, animals, plants, fungi and microorganisms such as bacteria. While certain forms of biological weathering, such as the breaking of rock by tree roots, are sometimes categorized as either physical or chemical, biological weathering can be either physical or chemical. Biological weathering can work hand in hand with physical weathering by weakening rock or exposing it to the forces of physical or chemical weathering.
- Lichens and mosses grow on essentially bare rock surfaces.
- Create a more humid chemical microenvironment.
- The attachment of these organisms to the rock surface enhances physical as well as chemical breakdown of the surface micro layer of the rock.
- On a larger scale, seedlings sprouting in a crevice and plant roots exert physical pressure as well as providing a pathway for water and chemical infiltration.\

THE END