UNIT – I

PHYSICAL GEOLOGY

SYLLABUS

Geology in civil engineering – branches of geology – structure of earth and its composition - weathering of rocks – scale of weathering – soils – landforms and processes associated with river, wind, sea and groundwater, relevance to civil engineering - Plate tectonics – Earth quakes – Seismic zones in India.

1.1 GENERAL GEOLOGY

Introduction:-

Geology(in Greek, Geo means Earth, Logos means Science)

- Geology is the branch of science deals with the study of Earth.
- It is also known as earth science.
- The study of earth as whole, the origin, structure, composition and the nature of the processes.

1.1.1 GEOLOGY IN CIVIL ENGINEERING

Engineering Geology

The principles and methods of geology is adopted for the purpose of civil engineering operations. Broadly speaking, engg geology has two divisions:

1. The study of raw materials
2. The study of the geological characteristics of the area where engineering operations are to be carried out such as Groundwater characteristics; the load bearing capacity of rocks; the stability of slopes; excavation; rock mechanics etc for civil engineer.

Scope of Geology

In Civil Engineering

- ✓ Geology provides necessary information about the construction materials at the site used in the construction of buildings, dams, tunnels, tanks, reservoirs, highways and bridges.
- ✓ Geological information is most important in planning stage, design phase and construction phase of an engineering project.
- ✓ Geology is useful to know the method of mining of rock and mineral deposits on earth's surface and subsurface.
- ✓ Geology is useful for supply, storage and filling up of reservoirs with water.

Importance of Geology in Civil Engineering

- Before constructing roads, bridges, tunnels, tanks, reservoirs and buildings, selection of site is important from the point of stability of foundation.
- Geology provides a systematic knowledge of construction materials and their properties.
- The *foundation problems* of dams, bridges and buildings are directly related with geology of the area where they are to be built.
- The *knowledge of ground water* is necessary in connection with excavation works, water supply, irrigation and many other purposes.
- The knowledge of *Erosion, Transportation and Deposition* (ETD) by surface water helps in soil conservation, river control.
- *Geological maps* and sections help considerably in *planning* many engineering projects.
- If the geological features like faults, joints, beds, folds are found, they have to be suitably treated. Hence, the *stability of the rock structures* is important.
- Pre-geological survey of the area concerned reduces the *cost* of planning work.
- Minerals, Rocks and soils constitute earth materials. They play a vital role in the site evaluation and operations in civil engineering practice.
- Whether it is tunnelling, hydro-electric projects, ground water development, foundation for structures, study of slope stability etc. A basic understanding of the earth materials is essential.

- Thus, study of minerals, rocks and soils forms the first step in civil engg point of view. Hence, a civil engineer should know the introduction of Geology and its branches and importance of a few branches such as Physical Geology, Petrology; Structural Geology and so on.

1.1.2 BRANCHES OF GEOLOGY

Geology comprises the following branches:

1. Crystallography
2. Mineralogy
3. Petrology
4. Geophysics
5. Geochemistry
6. Structural Geology
7. Stratigraphy
8. Physical Geology
9. Geomorphology
10. Paleontology
11. Hydrogeology
12. Engineering Geology
13. Photo Geology
14. Economic Geology
15. Mining Geology

- **Crystallography**: The study of the characters of crystals is known as crystallography. Crystals are bodies bounded by flat faces (surfaces), arranged on a definite plane due to internal arrangements of atoms.

- **Mineralogy:** The study of the characters of minerals (Eg: quartz, pyroxene, amphibole, mica, chlorite, garnet) is known as Mineralogy. A mineral is a naturally occurring homogeneous substance, inorganically formed with a definite chemical composition, with a certain physical properties and crystalline structures.

  Note: Coal, oil etc are considered as minerals though they arises by organic matter under exceptional conditions.

- **Petrology:** The study of rocks in all their aspects including their mineralogies, textures, structures (systematic description of rocks in hand specimen and thin sections); origin and their relationships to other rocks.

- **Geophysics**: The section of the earth which include the structure, physical conditions and evolutionary history of the earth as a whole.

- **Geochemistry**: The study of chemical composition of minerals and rocks of the earth.

- **Structural Geology** is the study of rock structures such as folds that have resulted from movements and deformation of the earth's crust.

- **Stratigraphy**: The study of the stratified rocks especially their sequence in time, the character of the rocks and correlation of beds at different localities.

- **Physical Geology**: It deals with the geological processes which bring about changes in the crust and upon the surface of the earth. It also deals with the surface features of the earth (land forms) or its topography

- **Geomorphology**: The description and interpretation of land forms.

- **Palaeontology** is the study of ancient life, determination of environment, evolution of organisms etc.

- **Hydrogeology** the study of the geological factors relating to earth's water.

- **Mining Geology** deals with the method of mining of rocks and mineral deposits on earth's surface and subsurface.

1.1.3 STRUCTURE OF EARTH AND ITS COMPOSITION

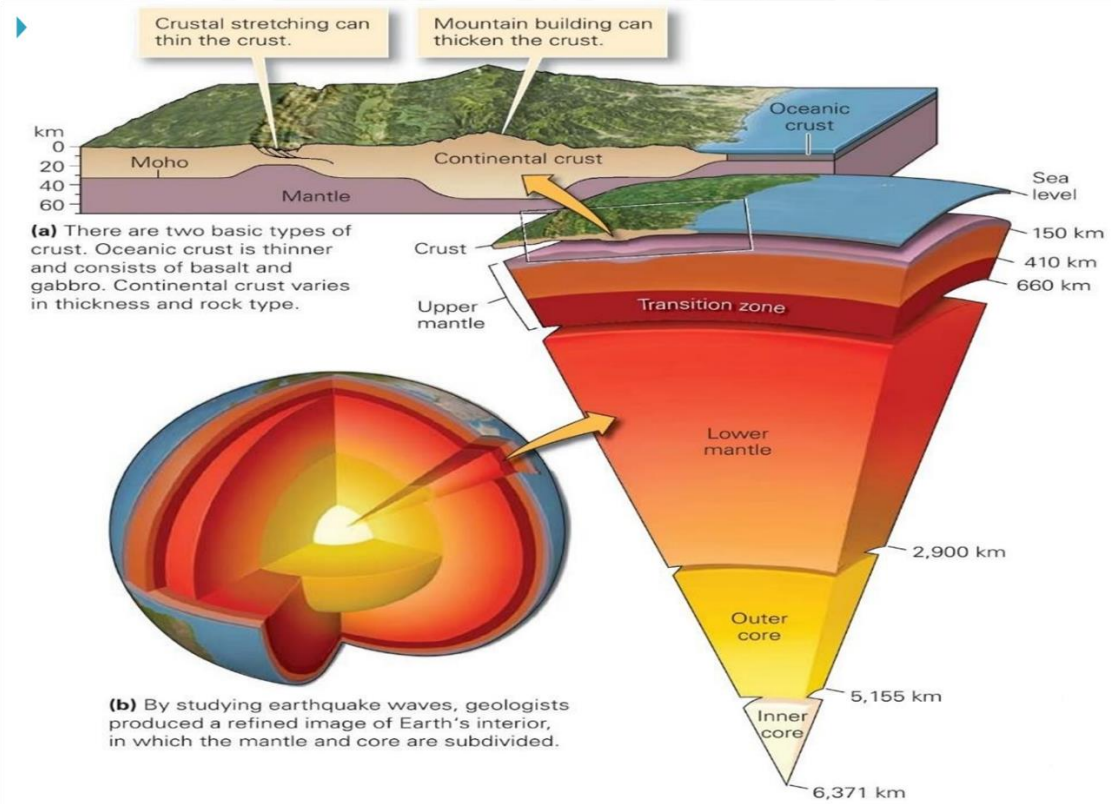
Introduction about Lithosphere:

- Litho is a Greek word, which means stone. Accordingly the lithosphere is the part of the Earth, which is solid crust.
- The thickness of lithosphere is approximately 50 km. The crust thickness is not the same at all places.
- It is thicker in the continent and thinner on the ocean floors. Lithosphere is a source of various minerals.
- It contains variety of landforms such as mountains, plateaus, valleys, plains.

Plates:

- The surface of the earth is the crust of the earth. It is made of interlocking pieces called Plates.
- The continents and oceans rest in these places and are separated by wide cracks. The plates move constantly.

STRUCTURE OF EARTH



Crust:

- Early in the 20th century the reality of earth crust was demonstrated by a scientist named Mohorovicic.
- He noted that in measurements of seismic wave arriving from an earthquake, those focus lay within 40km of the surface, seismographs within 800 km of the epicentre.
- Recorded two distinct sets of P and S-waves.
- He concluded that one part of waves must have travelled from the focus to the station by a direct path whereas the other pair of waves had arrived slightly later because they had been refracted.

There are two types of crust:

- Continental crust
- Oceanic crust.

Continental Crust:

- ✓ The continental crust consists of two layers separated by a well-defined discontinuityknown as Conard discontinuity.
- ✓ The layers have been defined on the basis of seismic wave velocities and densities.
- ✓ In the upper layers the velocity of seismic waves corresponds to the velocity found byexperimental to be characteristic of granite.
- ✓ Hence they are called as Granitic or silica layer.

Oceanic Crust:

- The earth's crust beneath the oceans consist of a low velocity layer of deep sea sediments about 300-400m thick in pacific and 600-700 m in the Atlantic.
- The Layer of intermediate velocity called basement about 0.8 km thick, composed of compacted and indurated sediments and lave flows.
- The third layer is called the oceanic layer about 4.1 to 5.8 km thick and certain composition. This three-layered oceanic crust is generally 5 to 8 km thick.

Mantle:

- Materials making the earth become quite different in properties at the base of the crust.
- This depth below the surface of the earth at which a striking change in the properties of the materials is observed has been named as Mohorovicic discontinuity.
- In geological literature itis often referred as M-discontinuity or simply as Moho.
- Hence mantle is that zone within theearth that starts from M-discontinuity and continues up to a depth of 2900km.Mantle is made up of extremely basic material called aptly ultra-basic that is very rich iniron and magnesium but quite poor in silica. The material of the mantle is believed to be variably viscous in nature.

Core:

- ❖ It is the third and the innermost structural shell of the earth as conclusively proved by the seismic evidence.
- ❖ It starts at a depth of 2900 km below the surface and extends right up to the centre of the earth, at a depth of 6371km.
- ❖ The core remains a mystery in many ways.
- ❖ Within the core the physical nature and composition of the material is not uniform throughout its depth.
- ❖ It has a very high density at mantle core boundary above 10g/cc.
- ❖ The outer core behaves like a liquid towards the seismic waves.
- ❖ The inner core starting from 4800km and extending up to 6371km is of unknown nature but definitely of solid character and with properties resembling top a metallic body.