ENGG. GEOLOGY

UNIT- 3

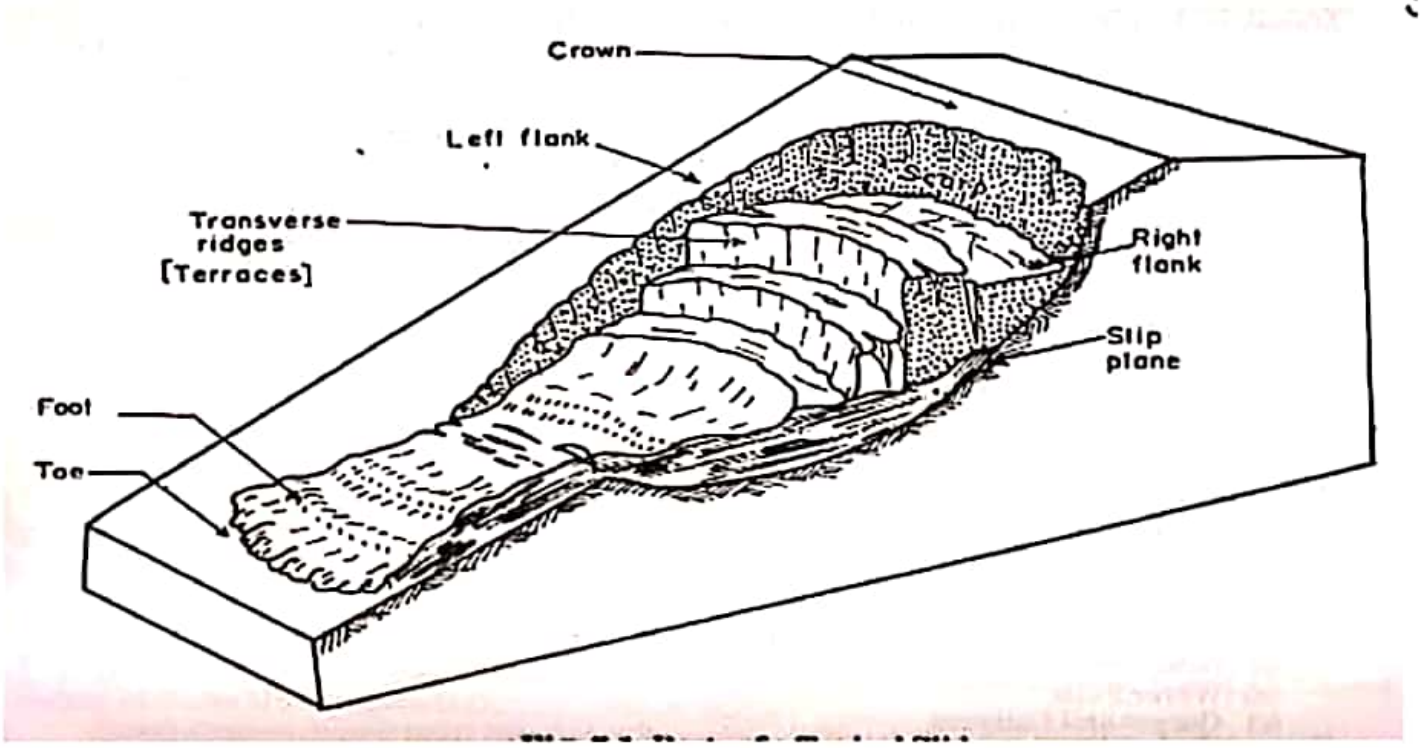
Topics Covered: landslides – its causes, classification & types of landslides, Preventive measures of landslide. Settlement & subsidence.

LANDSLIDE

A landslide is a slow or sudden downhill movement of slope forming rock and soil material under the force of gravity. Landslides or slopes failures are natural Erosional process. They occur in hillsides valley slopes, seacoasts, riverbanks and bends, on the slopes of volcanic cones and in earthquake prone areas. They also occur underneath as on lake or sea floor. Man in his urban and regional development activities also trigger landslides. Such as excavations, fills quarries, cuttings of roads, railway and canals etc. Landslides as natural erosional process not only modify the existing topography and landscape, they also cause immense damages to manmade structures and heavy loss of life.

PARTS OF TYPICAL SLIDE

A typical slide exhibits the following parts or regions



CROWN: - The upper portion still in place from which solid rock and soil materials are torn away from the rest of the slope.

SCARP: - The steep wall of the undisturbed material below crown around the periphery of the slide material

HEAD: - The upper part f the slide material

SLIP PLANE: - The shear surface – the surface of movement downhill of the slide material

FLANKS: - Sides of a slide, left flank and Right Flank

TRANSVERSE RIDGES: - Terrace or step like pressure or compression ridges

FOOT: - The line of intersection of the lower part of the slip plane and the original ground surface

TOE: - The lower portion in which the rock or soil material is heaped up

LENGTH: - Horizontal distance from crown to toe.

WIDTH: - Horizontal distance form flank to flank

HEIGHT: - Vertical distance, crown to toe

DEPTH: - Thickness of the slide mass between crown and foot.

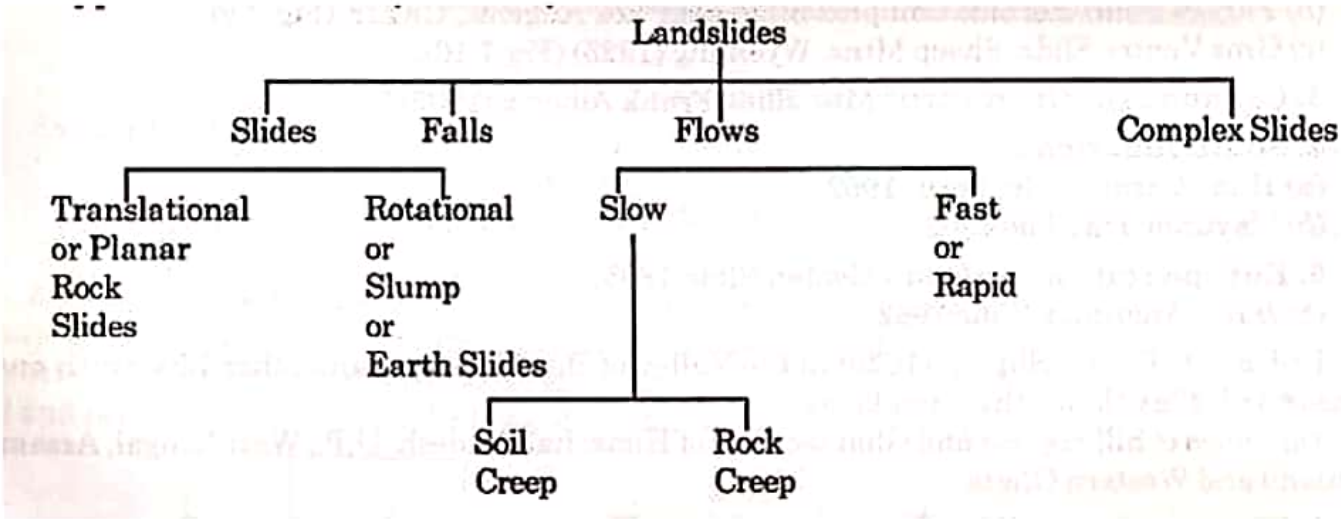
CLASSIFICATION AND TYPES OF LANDSLIDES

Landslides are of many types and are broadly classified according to their characteristic parameters

-Presence or absence of a definite slip plane

-Materials involved and their water content

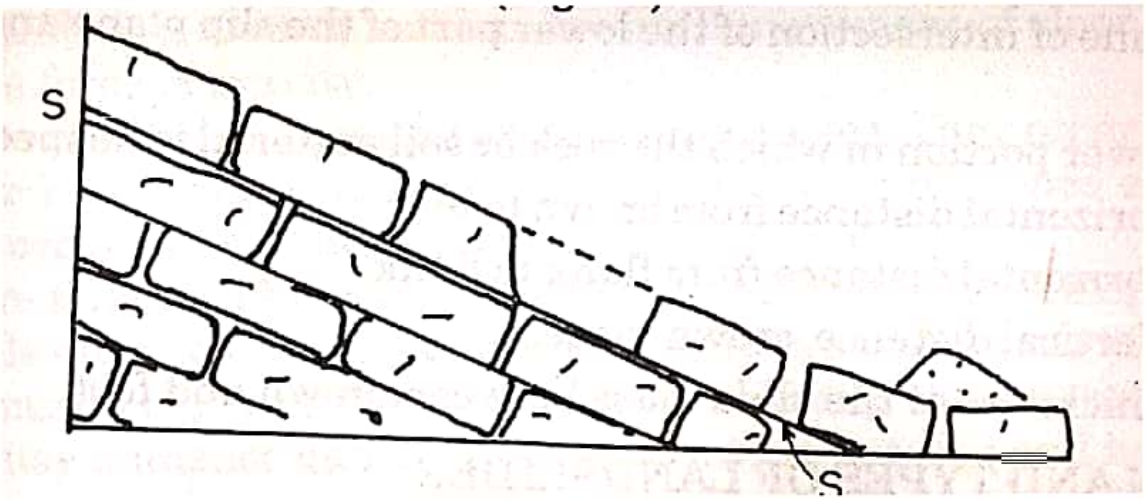
-Kind and rater of movement.



SLIDES: - Sudden downhill movements of rock and or unconsolidated rock material on a definite identifiable water lubricated or not down slope inclined plane called a shear or slip plane between the separating and remaining masses. The slip plane may be a bedding plane, joint plane, fault plane, and schistose or cleavage plane.

Slide movement: Slide movements are of two kinds according to the nature of the slip plane.

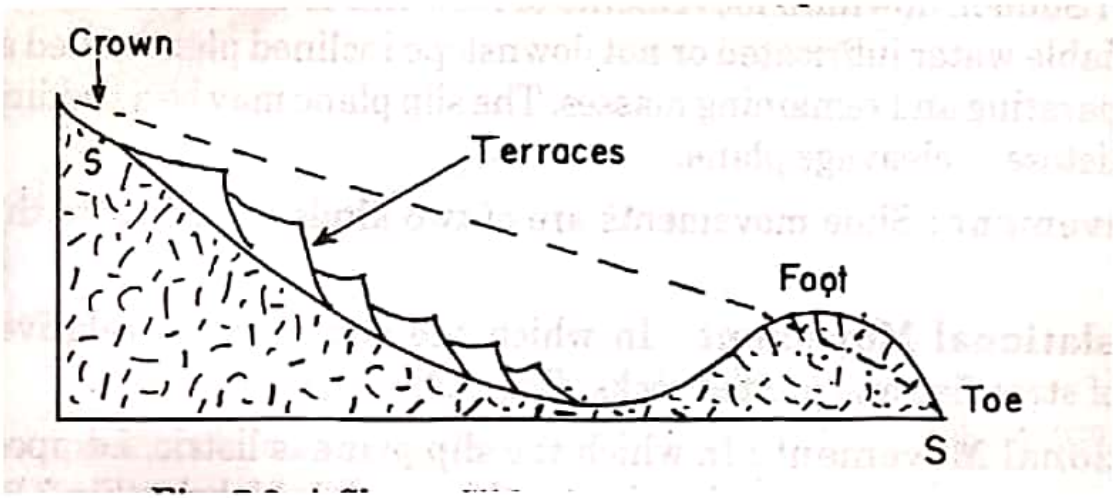
Translational Movement: - In which the slip plane in relatively a plane surface characteristic of stratified and jointed rocks.



Rotational Movement: - In which the slip plane in is spoon shaped, concave upwards, characteristic of unconsolidated or earth materials

Rock Slides (Block or planar slides): - These are typical translational slides common in slopes with stratified and jointed rocks and involve sudden or rapid movement of un deformed strata or blocks of rocks separated along joints or down slope dipping bedding planes at critical angles where the gradient of the slope is steeper than the dip of the beds. One or several of the water lubricated bedding planes form potential slip planes. The beds hold only so long as there is cohesion between them. When the dip approaches at the angle of limiting friction, the whole sequence of top strata above the slip plane slides down.

SLUMP: - These are typical rotational slides common in unconsolidated materials especially mud and clay. These occur when the foot or toe of a slope is cut away either by natural erosion or by human activity. These are also called slip outs. The slip plane is highly spoon shaped curved upward. The failed mass characteristically gets slumped at the toe area of the original slope, when a slope suffers multiple slides a terrace like features results.

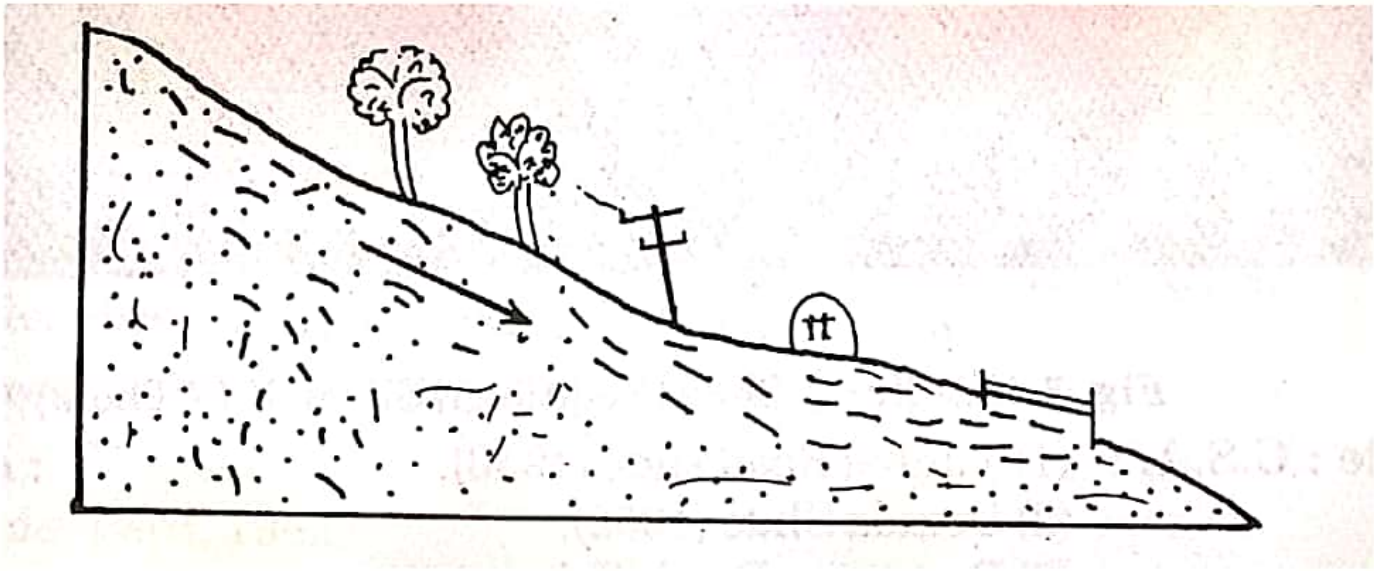


FALLS (Rock Falls): - Sudden and very rapid free fall leaping, rolling and or bouncing of detached blocks and boulders of rocks along joints and bedding planes of barren outcrops and solid bed rock materials in very steep slopes especially cliffs, overhanging cliffs and in steep hillsides, road and railway cuts following the laws of free falling bodies

FLOWS: - Slow to fast downhill movement of unconsolidated materials, earth sand and rock debris, dry or wet with water or ice and snow and in some cases bedrock itself. Flows are characterized by the absence of a recognizable slip plane. The movement resembles those of viscous fluids. Flows are of two types according to the materials and rate of movement slow or fast.

Slow Flows: - These are of two types

(a). Soil Creep: - A very slow almost imperceptible down slope plastic movement of wet or dry surface materials following the laws of viscous flows of fluids and semi fluids. Curved tree trunks recognize soil creep, tilted lampposts telegraph as well as displacement or destruction of foundations, buildings, and retaining walls, fences etc on sloping grounds



If water saturated materials are involved soil creep is called solifluxion and when it it's a wet mud without vegetation mud flow. Mudflows are common in areas effected by wild forest fires and on slopes of volcanic cones.

Fast Flows (Rapids Flows): -

Fast flows are sudden and very fast-to-fast downhill slide of soil, rock debris and boulders with large masses of ice and snow on steep slopes of Snow Mountains. It includes disruption of highways, railroads, recreation facilities heavy damage to buildings and loss of life.

CAUSES OF LANDSLIDES

Many factors are causing a mass of material to slide or flow. Some of them play a direct role and are easily understand whereas others are indirectly responsible for the instability of the landmass. All such factors that facilities land sliding is one way or another is generally grouped in tow headings.

1) Internal Factors

2) External Factors

Internal Factors: - These include such causes, which tend to reduce the shearing of the rock, further it is classified into, 1) the nature of slope, 2) water content, 3) composition and compaction of the mass, 4) geological structures

1) **the nature of slope:** - Some slopes are very stable even when very steep whereas other are unstable, even at very gentle slope. But a great majority of failure are confined to slopes only, indicating that slopes are directly responsible for mass failure.

2) **Water content:** - Much importance is attached to the role of water is causing mass movements. It may act in a number of ways to reduce the shearing strength of the rock or soil mass. Even presence of water in the pore spaces of rocks has been found to affect all the strength properties adversely. When water within the mass is also capable of flow around the grains. Similarly, when water happens to move along a plane of weakness within the mass, that plane gets lubricated and may turn into an effective plane of shear failure. In sliding type of failure this lubricating action is of great importance.

3) **Composition and compaction of the mass:** - Some materials are stable in a given set of conditions of slopes and water content whereas others may be practically unstable under those very conditions. This clearly suggests that compaction plays an important part in defining the stability of the masses. Sandstone exhibits a great variation in chemical composition. Siliceous Sandstones would be highly stable even during intensive rains and at steep slopes whereas clayey or calcareous may suffer repeated failure under same conditions.

Along with composition, the texture of rocks plays an important part-It indicates the degree and manner of packing of grains or crystals. Porosity and permeability of are the two important factors influencing the percolation of water through the mass.

4) **geological structures:** - Of all the geological structure the inclination(dip), joints, faults zones of the strata, presence or deposition of shear, fault zone, joints and other planes of weakness are important in defining their stability.

External Factors: - Earthquakes and blasting around mines due to this vibration is liberated from this mass failure may take place.

Preventative measures of Landslides

Many methods for controlling the slides are available and choice of many methods will depend of factors like nature of slide, the underlying cause for it, the nature and amount of material involved and the economical consideration, of such method most important are.

1) Providing adequate drainage

2) Construction of retaining walls

3) Stabilizing the slopes

Providing adequate drainage: - It involves the removal of moisture form within the rocks as well as preventing any further moisture to approach the material to sliding. This may be achieved either by surface drainage or by subsurface drainage; construction of interpretation ditches, waterways, trenches and drainage tunnels may become necessary. Grouting the joints and other fractures may also prove helpful.

Retaining structure: - Al such devices like construction of retaining wall etc. are aimed at stopping the moving mass by force and their success is always doubtful. Construction of

retaining wall requires an accurate assessment of the forces, which the wall has to withstand. Retaining walls may prove exceptionally, successful where,

A) The ground is neither too fine nor too plastic

B) The sliding mass is likely t remain dry

C) The movement is of shallow nature

Slope treatment: - When the material is soil and situation is a slope the failure is attributed to a loss of stability. In such cases the treatment involves stability for the particular type of soil and slope and if such computation indicate that a given slope of soil will not be stable then the solution lies in either,

A) Flattening the slope

B) Decreasing the load

C) Increasing the shearing resistant of the soil by decreasing its water content with help of drains and evaporation

D) A forestation that is growth of vegetation cover with intricate and interwoven root system has also been found useful in stabilizing the barren slopes.

Settlement & Subsidence:

Settlement usually occurs in new or relatively new buildings. They are very heavy and cause the ground to compact, but this normally stops after a short while.

Subsidence on the other hand is far more serious and occurs when the ground beneath the building is unable to support it. To rectify this problem, in most cases, the property will be underpinned, which is a combination of steel and poured concrete underneath the property, to make the affected area stable.