

***Land***



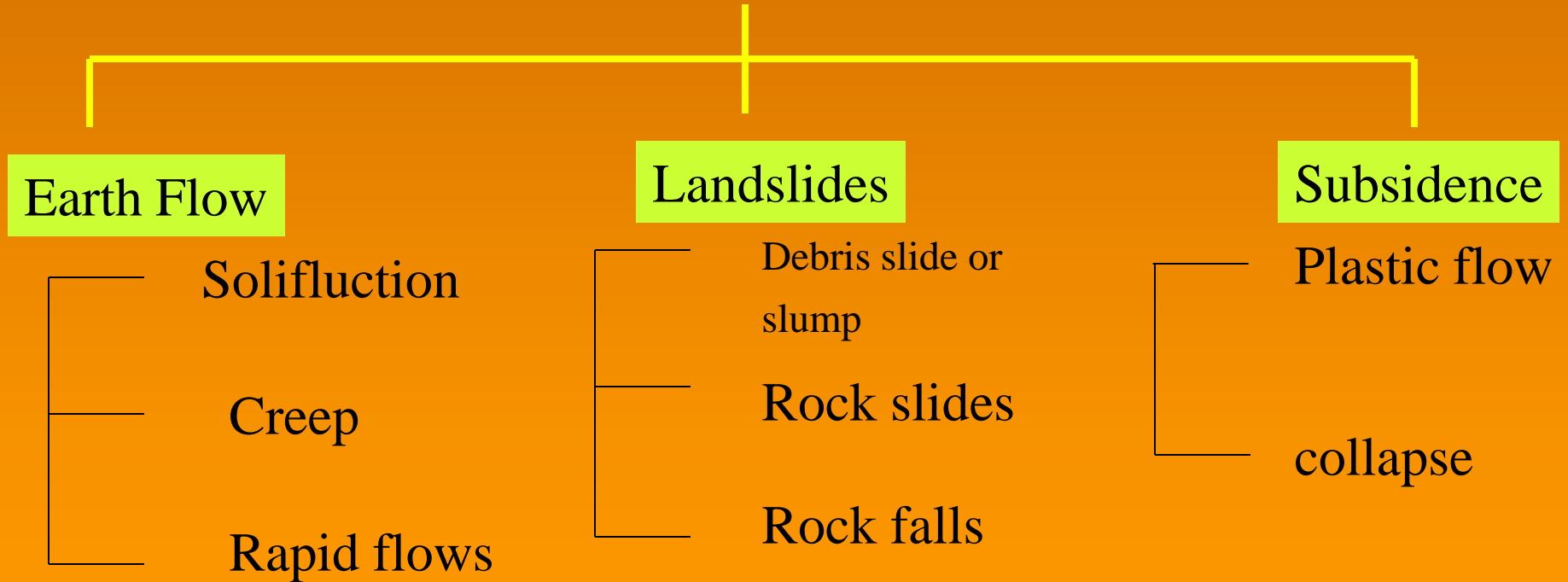
***slides***

*Landslide: refers to the downward sliding of huge quantities of land mass*

*which occur along steep slopes of hills or mountains and may be sudden or slow*

# Classification of Earth Movements

- All movement of land masses are referred as landslides, but differ in many respects, therefore all types of landslides are categorized as Earth Movements.
  - These are classified as



# ***SOLIFUCTION***

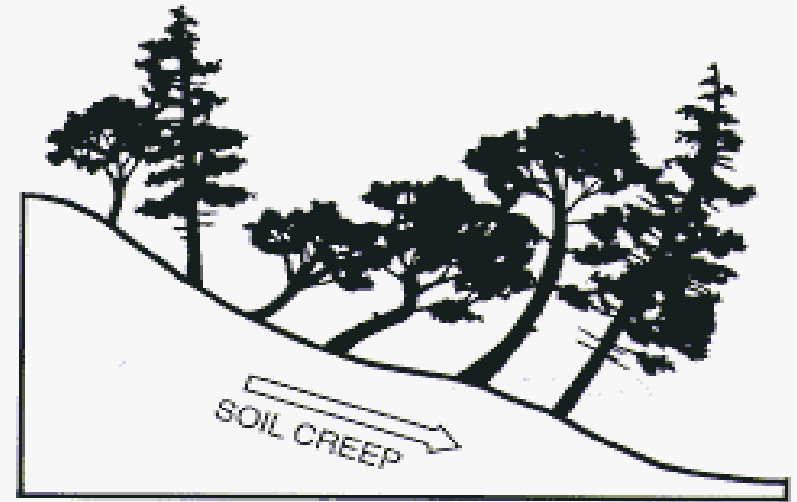
- Solifuction is a downward movement of wet soil along the slopes under the influence of gravity.





# SOIL CREEP

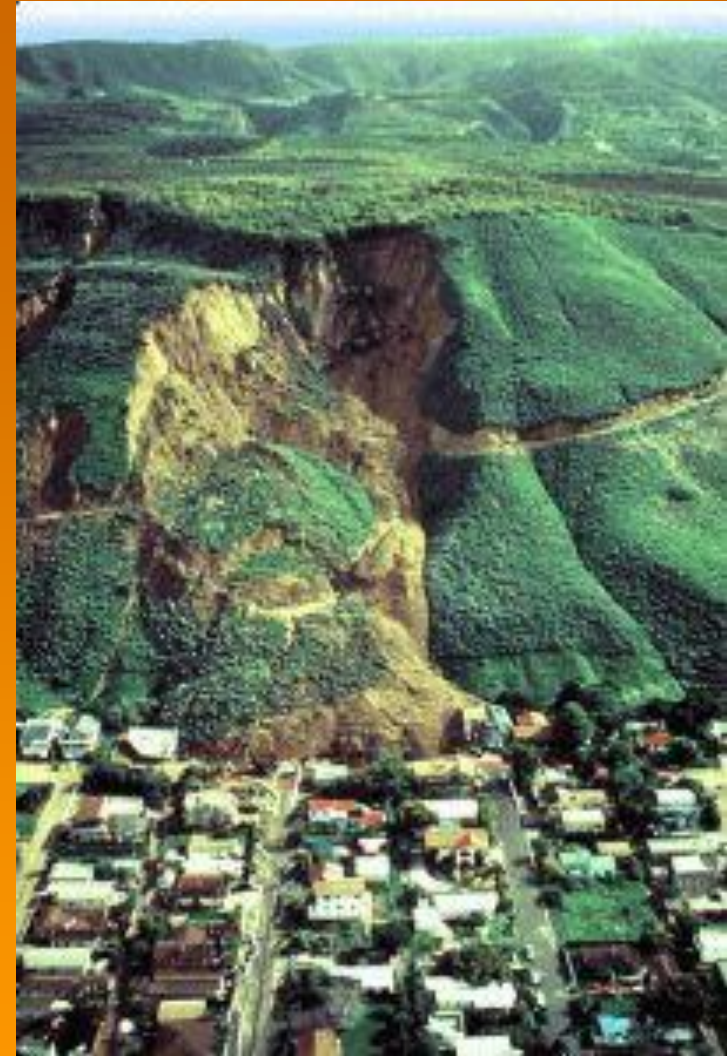
- Creep is extremely slow downward movement of dry surfacial matter.
- Movement of the soil occurs in regions which are subjected to freeze-thaw conditions. The freeze lifts the particles of soil and rocks and when there is a thaw, the particles are set back down, but not in the same place as before.
- It is very important for CEs to know the rate of movement



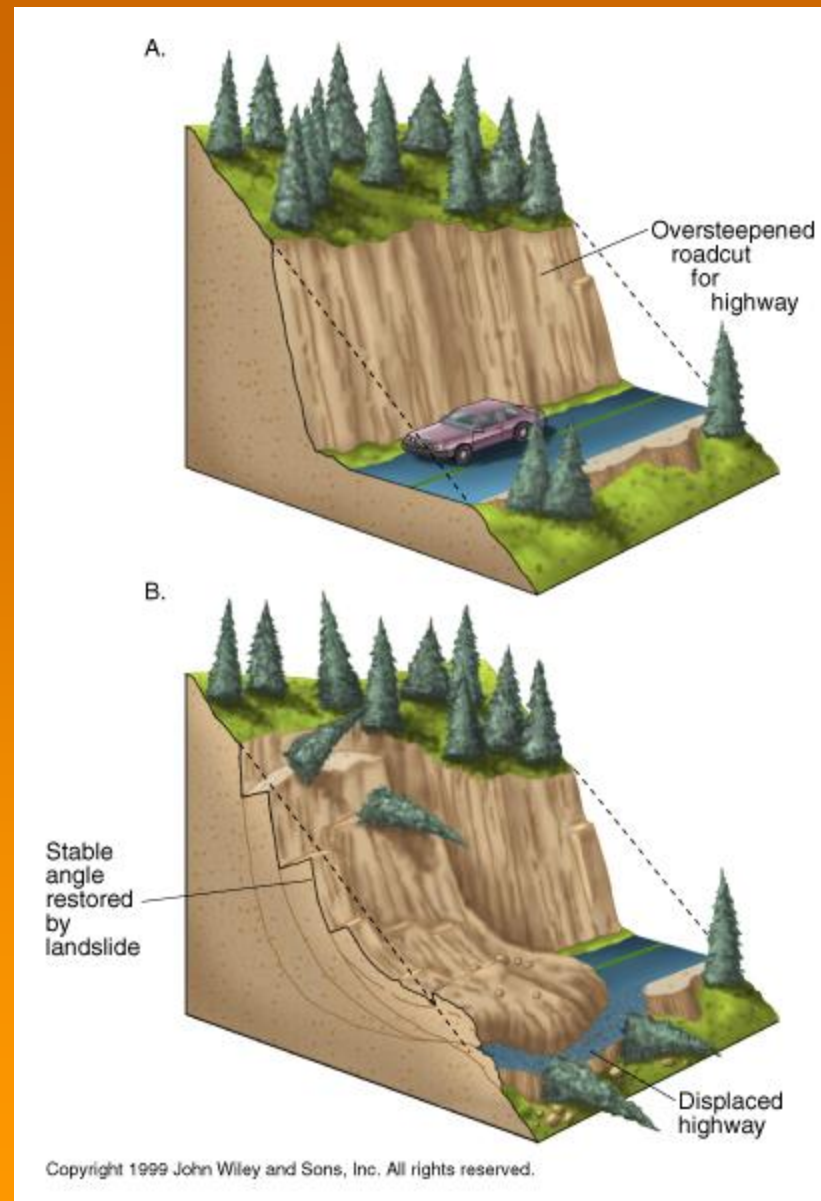
- *RAPID FLOWS: Rapid flow is similar to the creep, but differ in terms of speed and depth. It is faster.*
- *Creep is involved upto shallow depth (app. 1-2 m), whereas the rapid flow is involved to greater depth (app. upto 5 m or more)*

# Landslides

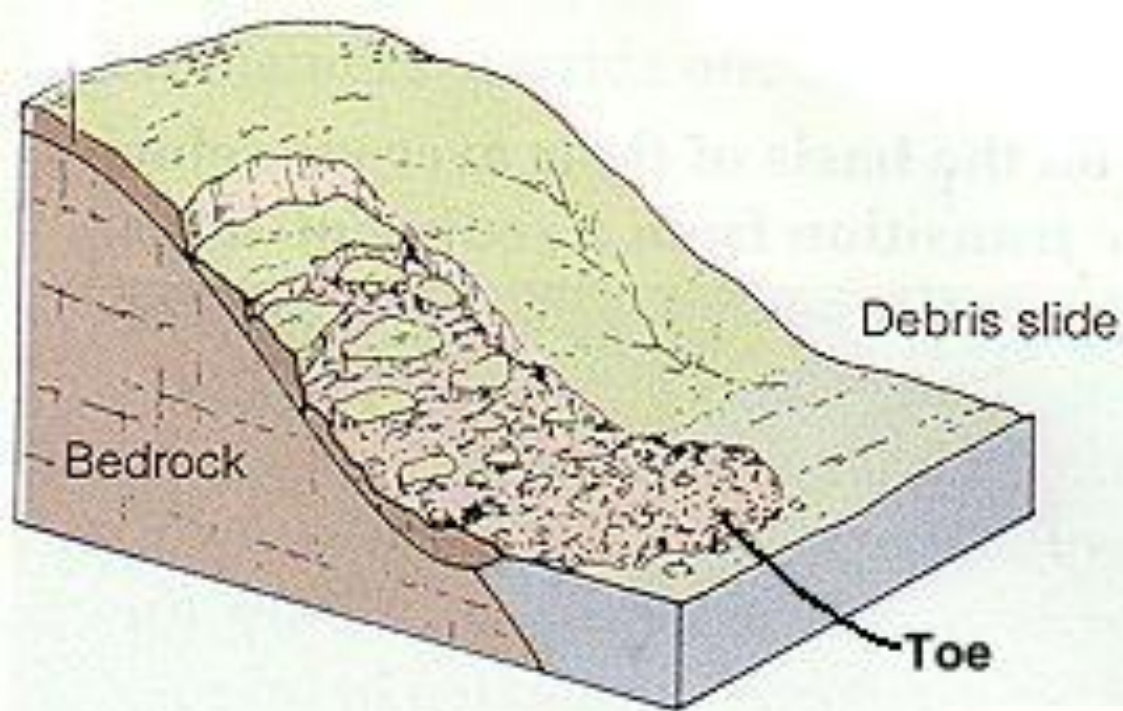
- If a mass of earth moves along a definite plane or surface the failure is termed as Landslide
- Large block known as a slump block moves during the landslide.
- The scar above a landslide is easily visible.
- They can occur along a slope where the internal resistance of the rocks are reduced or they lose their holding capacity.
- Common after earthquakes or after removal of part of the slope due to construction, particularly for construction of roads.



- During the movement landslide can result into the Debris slides - are failure of unconsolidated material on a surface; Rock slide or Rock Fall – where movement of large rock block rolls
- They are also common along the steep banks of rivers, lakes etc.
- Pore Water Pressure is the key to monitoring landslides. Shear strength (a resisting force) decreases and the weight (a driving force increases).







- Talus – accumulation formed by the coarser rock fragments resulted from the mechanical weathering along a slope under influence of gravity

## Rockfall



# Subsidence

- It represents the downward movement of the surface
- It may occur due to plastic outflow of the underlying strata or due to the compaction of the underlying material
- (1) **Subsidence due to Plastic outflow:** It may occur when a plastic layer like clay bed is squeezed outward due to overlying heavy load
- (2) **Subsidence due to collapse:** It occur due to extensive pull out of large volume of underground water or due to subsurface solution activity in limestone terrain.







- The Leaning Tower of Pisa, Italy, the tilting of which accelerated as groundwater was withdrawn from aquifers to supply the growing city.



# CAUSES OF LANDSLIDES

- **LANDSLIDES OCCUR DUE OF VARIOUS REASONS**

- Internal Causes:

- **Influence of slope-** Provides favourable condition for landslides; steeper slope are prone to slippage of land. It is known that most of the materials are stable upto certain angle- “Critical angle” or “angle of repose” – it varies from  $30^{\circ}$  for unconsolidated sediments to  $90^{\circ}$  for massive rocks and  $60^{\circ}$ - $90^{\circ}$  for partially jointed rocks.
- **Ground water or associated water-** Main factor responsible for slippage. Suppose the hard or massive rocks are underlain by softer rocks (shale or clay bed)
- When rain water percolates through some fractures or joints the clayey beds becomes very plastic and acts as slippery base, which enhance the chances of loose overburden to slip downward.
- Water is the most powerful solvent, which not only causes decomposition of minerals but also leaches out the soluble matter of the rock and reduces the strength.

- **Lithology-** rock which are rich in clay (montmorillonite, bentonite), mica, calcite, gypsum etc are prone to landslide because these minerals are prone to weathering.
- **Geological structures-** Occurrence of inclined bedding planes, joints, fault or shear zone are the planes of weakness, which create conditions of instability.
- **Human Influence-** undercutting along the hill slopes for laying roads or rail tracks can result into instability.
- Deforestation in the uplands, result into more erosion during the rainy season.

- **External factors**

- Most common is the vibration resulted due to earthquakes; blasting to explosives; volcanic eruption etc.
- Earthquakes often initiate mass failures on large scale eg. 1897 Assam quake produced gigantic landslide ever recorded in the region.

# PREVENTIVE MEASURES



- The main factors which contribute to landslides are *Slope, water content, geological structure, unconsolidated or loose sediments, lithology and human interference.*
- **Slope: Retaining wall may be constructed against the slopes, which can prevent rolling down of material. Terracing of the slope is an effective measure.**
- **Effect of water: Make proper drainage network for quick removal of percolating moisture or rain water by constructing ditches and water ways along the slope**
- **Geological structures: Weak planes or zones may be covered or grouted to prevent percolation of water, this increases the compaction of loose material.**



- **LANDSLIDES AND MUDFLOWS**

- Plant ground cover on slopes and build retaining walls.
- In mudflow areas, build channels or deflection walls to direct the flow around buildings.
- Install flexible pipe fittings to avoid gas or water leaks.