

## 5.5 INVESTIGATION OF LANDSLIDES, CAUSES AND MITIGATION

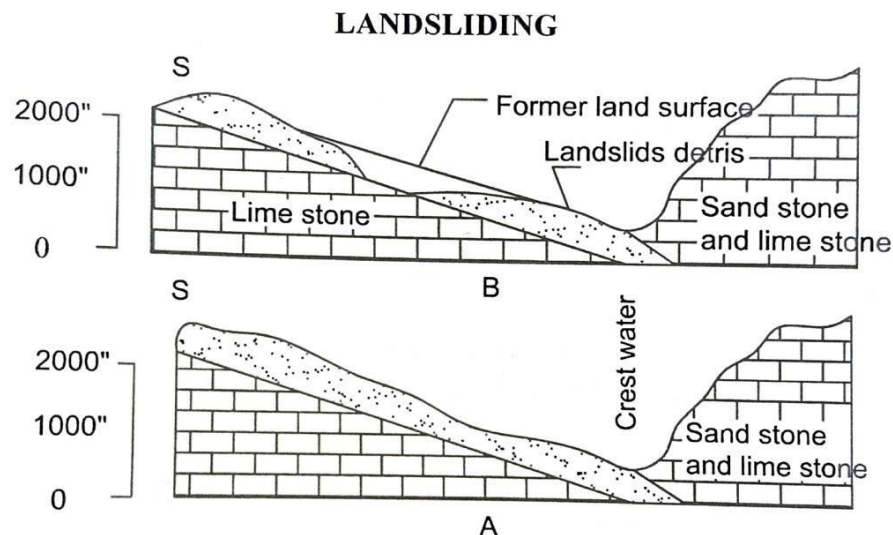
### Land sliding:

The downward movement of the superficial land masses, due to slope failure is called Land sliding or Mass movement.

### Causes of Land slide:

The following are the important causes of land sliding.

- Slope failure
- Movement of the tectonic plates.
- Earthquakes.
- Heavy rainfall.
- Geological factors such as soil conditions.
- Drainages conditions
- Deforestation
- Other artificial causes such as, Mining activities, Heavy traffic loads, etc.



### Classification of Land sliding:

The land sliding is broadly classified into three categories.

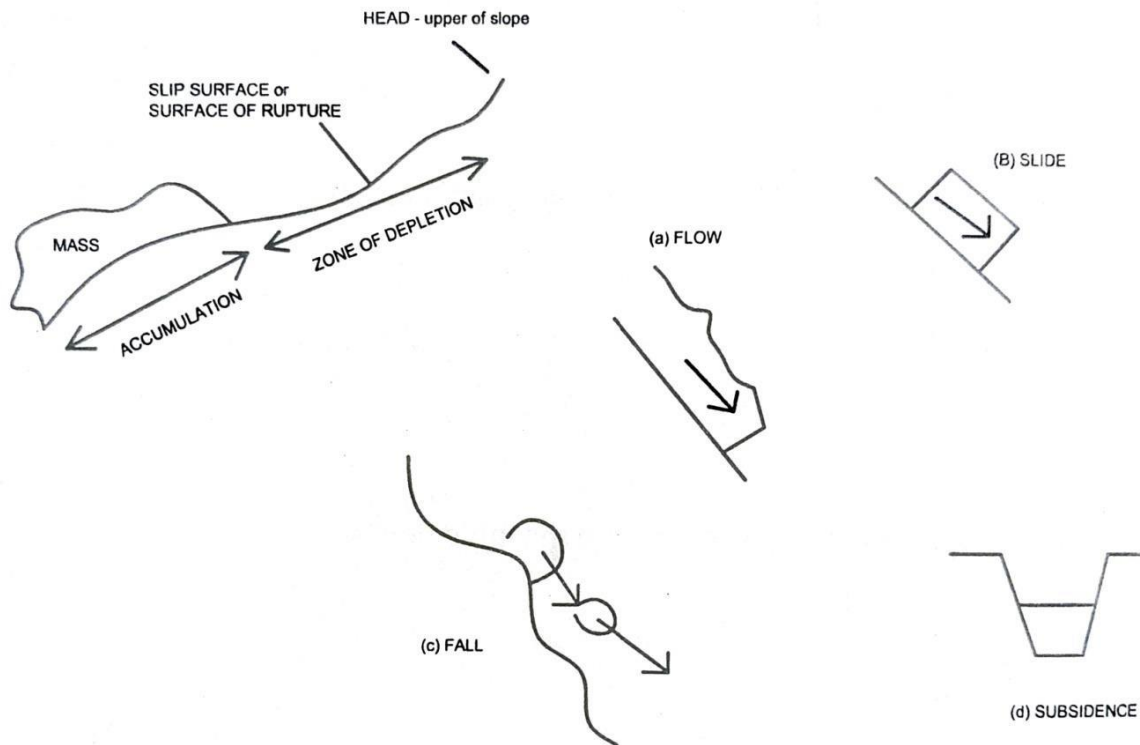
1. Flowage

2. Sliding
3. Subsidence

### I. Flowage:

Flowage is defined as the down grade irregular movement of superficial land mass, along no definite surface of failure.

### TYPES OF LANDSLIDING



In flowage, the movement is distributed throughout the mass.

### Types of flowage:

Flowage is divided into two types.

1. Slow flowage
2. Rapid flowage

#### 1. Slow flowage:

Movement is very slow, not visible, only few centimeters a year or less.

It is further classified into:

- i. Soil creep

ii. Talus creep

iii. Solifluction

**i. Soil creep:**

- Soil creep is a surface phenomenon.
- Only the top one meter of the soil is involved in failure, without much water content.

- The movement may be 1mm to few centimeters a year.

**ii. Talus creep:**

- The materials involved in failure are weathered rock debris & fragments (talus) along sloping terrain.

- The movement may be 10cm a year or more.

**iii. Solifluction:**

- Solifluction refers movement of soil mass in water saturated condition.
- It is characteristic phenomenon in extremely cold climatic regions.
- Porous and unconsolidated solids are involved in failure.

**2. Rapid flowage:**

Movement is visible, few meters or more a day.

It is further classified into:

i. Earth flows

ii. Mud flows

iii. Glacier flow

**i. Earth flows and Mud flows:**

- Un consolidated materials are involved in failure
- Both refer same types of failure, but with different water content.
- In mud flows, the quantity of water per unit volume of the soil mass is very high, compared to earth flows.

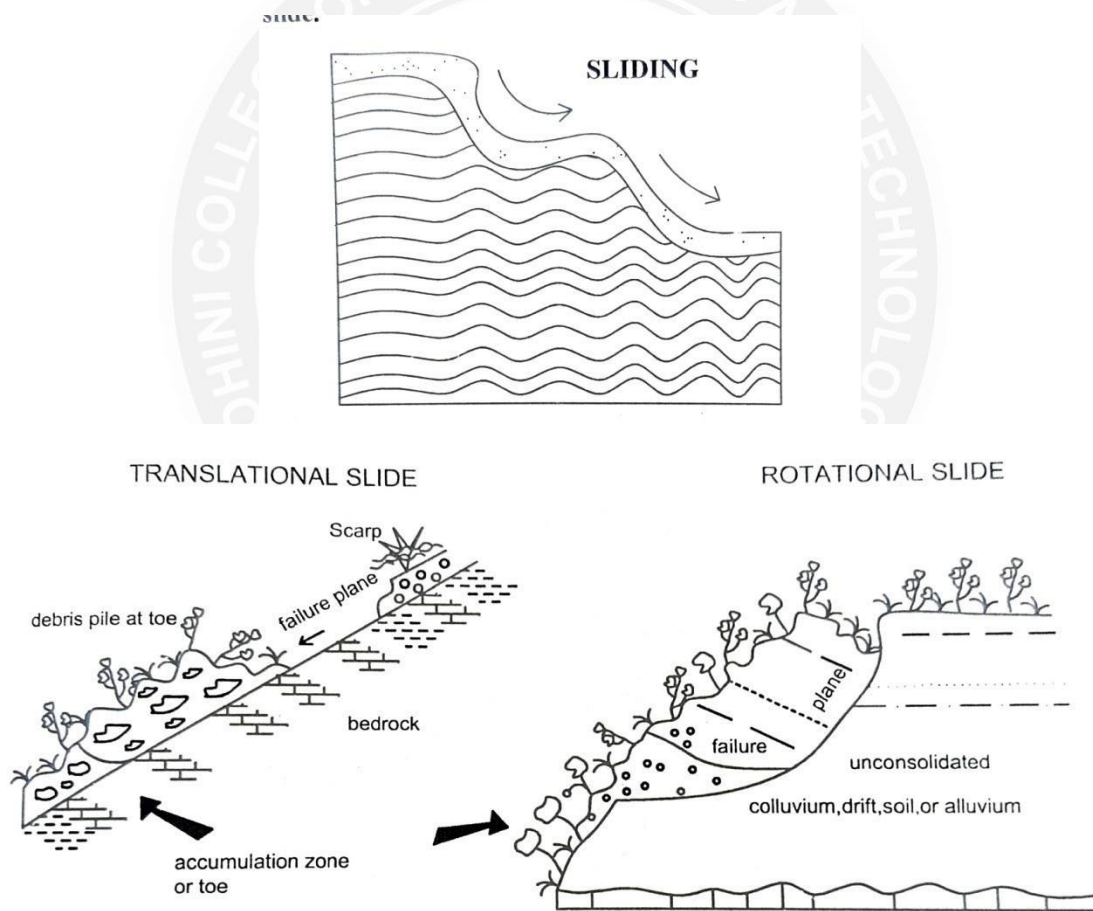
## ii. Glacier flow:

- Glacier flow occurs in permo frost region.
- In India, Himalayan ranges are evidenced with glacier flows.
- Glaciers bring broken rock debris and stones along with their flow.

## II. Sliding:

- This term refers the 'real or true' land sliding.
- Land sliding occurs along definite surface of failure.
- Sliding occurs along planar surface of failure or curved surface of failure.

If sliding occurs along planar surface of failure, then it is called translational slide.



- In rotational slide, the surface of failure is curved.
- Rock slide refers sliding of rock blocks.
- Debris slide refers sliding of unconsolidated fragments.
- Rock fall refers sudden falling of rock blocks.
- Debris fall refers sudden falling of unconsolidated debris.
- In sliding, Velocity of movement will be less than that of rock fall.

- Single rotational slide refers sliding of either rock block or debris.
- Multiple slides refer sliding of the combination of rock blocks and debris.
- **Avalanche:**

The downward movement of the huge solid rock blocks, weighing thousands of tons with terrific speed is called an Avalanche.

### III. Subsidence:

- The failure of ground in a vertically downward movement is called as subsidence.
- Subsidence is due to natural or artificial causes.

Natural causes:

- Presence of the structurally weak rock strata.
- Heavy rainfall.
- Solution of subsurface rocks.
- Vertical movement of the tectonic plates.
- Earth quakes etc.,

Artificial causes:

- Removal of the supporting materials.
- Mining.
- Over exploitation of oil and gas, ground water, etc.,

## MITIGATION AND PREVENTION CONTROL MEASURES OF LANDSLIDING:

### Prevention Control Measures:

1. Providing proper drainage.
2. Constructing retaining walls.
3. Providing rock bolts and rock anchors as reinforcement in slopes.
4. Providing slope treatment:
  - i. Slope terracing.
  - ii. Planting vegetation along slopes
5. Controlling traffic load, along slopes.
6. Promoting afforestation.

7. Preventing deforestation, etc.,

### **Mitigation Measures**

Landslide mitigation refers to lessening the effect of landslides by constructing various man made projects at slopes vulnerable to; in addition to shallow erosion or reduction of sheer strength caused by seasonal rainfall, causes triggered by anthropic activities such as adding excessive weight above the slope, digging at mid slope or at the foot of the slop, can also be included.

