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Review of Landslide in Konkan Region

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Abstract*: In this paper discussed landslide & the different types of mass movements. Its efforts on the environment are considered & special attention is given to the landslide of Konkan region. And also to study the feasibility of various construction methods and techniques to design protective measures against frequently occurring landslide problems on Konkan railway.*

1. Introduction

Landslide' is a general term for a variety of down slope movements of earth materials that result in the perceptible downward and outward movement of soil, rock and vegetation under the influence of gravity. The materials may move by falling, toppling, sliding, spreading, or flowing. Some landslides are rapid, occurring in seconds, whereas others may take hours, weeks, or even longer to develop. It includes various types of slope failure including earth and debris flows, slumps, slides, and soil and rock fall. Landslides are one of the normal landscape building processes in undulating terrain and are common in Himalaya and Western Ghats regions in India.

Landslides are not uncommon phenomena in Western ghat region. Every year during monsoon period the Konkan railway route faces number of unusual incidents like rock fall, soil slides, soil mixed boulder slide, spread along the track causes extensive damages to the track structure and human lives. Konkan railway carries thousands of passengers every day through its challenging terrain condition. Konkan railway has deep cuttings along its route with unfavorable slopes and extreme climatic conditions. The occurrences of slope failures are frequent in Konkan region particularly along the railway tracks hill slopes causing disruption in traffic, loss of lives and property. This demands a critical study of stability of slopes along the Railway track, to assess the vulnerability of slope failure. It would be help us to planning protective measures and disaster management for the Landslides reported from some of the areas of Konkan region for the safety and security of people and goods. And also to study the feasibility of various construction methods and techniques to design protective measures against frequently occurring landslide problems on Konkan railway.

2. Cause of Landslide

2.1 Geological Causes

1. Weak materials
2. Sensitive materials
3. Weathered materials
4. Sheared materials
5. Jointed or fissured materials
6. Permeability contrasts
7. Material contrasts
8. Rainfall

2.2 Morphological Causes

1. Vegetation change
2. Slope angle Uplift
3. Rebound
4. Fluvial erosion
5. Erosion of lateral margins
6. Subterranean erosion
7. Slope loading

2.3 Physical Causes

1. Intense rainfall
2. Prolonged
3. Precipitation
4. Rapid
5. Drawdown
6. Ground water Changes
7. Soil pore water
8. Pressure
9. Surface runoff
10. Seismic activity

2.4 Human Causes

1. Excavation
2. Land use change
3. Water
4. Management Mining
5. Quarrying Vibration
6. Water leakage Deforestation

3. Mass Movement

Mass movement is the movement of surface material caused by gravity. Landslides and rock falls are examples of very sudden movements of this type.

Due to geological agents such as water, wind and ice all work with gravity to cause a leveling of land.

3.1 Types of Mass Movement

Types of mass movement are distinguished based on how the soil, regolith or rock moves down slopes as whole.

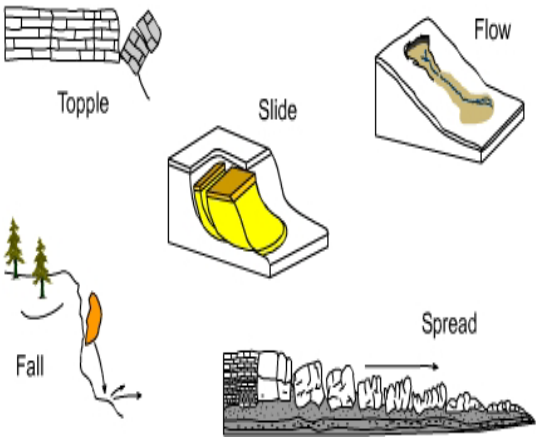

Figure 1: Types of Mass Movement

3.1.1 Slides:
The two major types of landslides are rotational slides and translational landslides

1. Rotational landslide**:** The surface of rupture is curved concavely upward (spoon shaped), and the slide movement is more or less rotational. A slump is an example of a small rotational landslide.
2. Translational landslide**:** The mass of soil and rock moves out or down and outward with little rotational movement or backward tilting. Translational landslide material may range from loose, unconsolidated soils to extensive slabs of rock and may progress over great distances under certain conditions.
3. Block Slide: A block slide is a translational slide in which the moving mass consists of a single unit or a few closely related units that move down slope as a relatively coherent mass.

3.1.2 Topple:
A block of rock that tilts or rotates forward and falls, bounces, or rolls down the slope

3.1.3 Fall:
Abrupt movements of materials that become detached from steep slopes or cliffs, moving by free fall, bouncing, and rolling

3.1.4. Flows
There are five basic categories of flows that differ from one another in fundamental ways

1. Debris flow: Rapid mass movement in which loose soils, rocks, and organic matter combine with entrained air and water to form slurry that then flows down slope, usually associated with steep gullies.
2. Debris avalanche: This is a variety of very rapid to extremely rapid debris flow.
3. Earth flow: Earth flows have a characteristic "hourglass" shape. The slope material liquefies and runs out, forming a bowl or depression at the head. The flow itself is elongate and usually occurs in fine-grained materials or clay bearing rocks on moderate slopes and under saturated conditions. However dry flows of granular material are also possible.
4. Mudflow: Rapidly flowing mass of wet material that contains at least 50 percent sand, silt, and clay-sized particles.
5. Creep: Slow, steady down slope movement of soil or rock, often indicated by curved tree trunks, bent fences or retaining walls, tilted poles or fences.

3.1.5. Lateral Spreads:
Lateral spreads usually are caused by liquefaction, where saturated sediments (usually sands and silts) are transformed from a solid into a liquefied state, usually triggered by an earthquake.

3.2 Types of Movement with Types of Material

The common types of landslides are described below. These definitions are based mainly on the work of Varnes (Varnes, D.J., 1978).

Type of movement		Type of materials		
		Bedrock	Engineering soils	
			Predominantly coarse	Predominantly Fine
Falls		Rock Fall	Debris fall	Earth fall
Topples		Rock Topple	Debris topple	Earth topple
Slides	Rotational	Rock slide	Debris slide	Earth slide
	Translational			
Lateral spreads		Rock spread	Debris spread	Earth spread
Flows		Rock flows (deep creep)	Debris flows	Earth flow
			(soil creep)	
Complex		Combination of two or more principal types of movement		

4. Protective Measures:

Landslide is a major disaster, which occurs in high relief areas, due to triggering mechanism like heavy rainfall and earthquakes. So landslide hazard prevention is very important to protect the live and property, infrastructures. Landslide Control in our country continues to move on the traditional ways. In most cases, a typical landslide package usually consists of a combination of slope dressing and treatment, surface and subsurface drainage and provision of restraining structures such as nailing, bolting, and anchoring, etc. Landslide prevention and mitigation can be achieved by civil engineering investigation, proper planning, design and execution. In civil engineering, advance techniques are developed day by day which should be used with proper back analysis. Following are some remedial measures:

1. Slope modification can be done by reducing the height of the slope by benching. Also by replacing the backfill with the light weight material is possible to avoid landslide.

Figure 2: Slope modification

2. Slope strengthening can also be done with the help of plastic mesh reinforcement, rock fill buttresses, retaining wall construction.

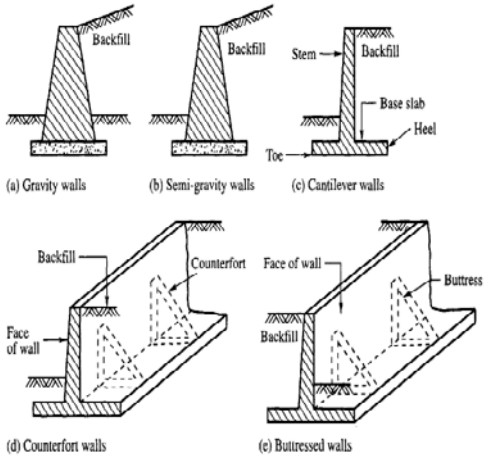

Figure 3: Various types of Retaining walls

3. Slope strengthening can also done by the help of steel bin wall, gabion wall structure etc.

4. Soil Nailing is geo-technical engineering solutions to strengthen the soil slope and avoids its failure.

Figure 4: Soil Nailing

5. Large diameter shear pile construction is also very useful in avoiding the landslide.

Figure 5: Micro Piling

6. Proper surface drainage is the key thing to avoid landslide. Adequate drainage is the basic & most important tool to avoid destabilizing the slope

7. Debris-flow basins**:** These catchment basins are commonly built at the base of slopes where debris flows are frequent. They are used especially in areas where the debris must be contained so that soil and debris are stopped from flowing into sensitive ocean or river shorelines areas or where there are structures at the base of the slope that are vulnerable to debris-flow damage .

Figure 6: Lining of catch water drains

8. Shotcrete and Gunite: Shotcrete and gunite are types of concrete that are applied by air jet directly onto the surface of an unstable rock face.

Figure 7: Shot-Creting

9. Anchors, Bolts, and Dowels: These are tools composed of steel rods or cables that reinforce and tie together a rock face to improve its stability.

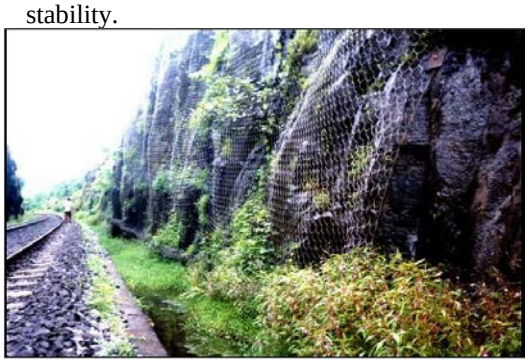

Figure 8: Boulder Netting

10. Vegetation on slopes is also very useful for the stabilization of slopes. Vegetation helps in controlling the erosion of surface. A forestation is very important to avoid destabilization of slopes. So avoiding cutting of trees is very important thing. Vegetation is being widely used for erosion control, to achieve slope stabilization along the transportation routes.

Figure 9: Vetiver Plantation

5. Conclusion

The above details suggest that landslide in the area is due to the combined effect of the natural and anthropogenic activities. If without understanding the natural geological and geomorphologic and hydrological condition, anthropogenic activities, landslides could be more severe in the forthcoming days and hence proper measures is suggested. This would help us in planning protective measures and disaster management for the landslides reported from some of the areas of Konkan region as they are of great concern for the safety and security of people.

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