

Slope and Landslide Stabilization: A Review

Gomasa Ramesh



Abstract Slope stabilization is the one of important fundamental aspect for preventing landslides. For a safer design of the structure, slope stabilization is very important. There are various studies conducted on slope stabilization and landslide mitigation. Geotechnical Engineers and Structural Engineers play an important role in analyzing and designing slope stabilization and landslide mitigation and prevention. This study is also helpful for the design of slopes. The study also helps for quick assessment of slopes. This paper also explained stabilization methods and techniques for slope. This study is also helpful in improving the shear strength of the slope of soil. This paper helps to understand basic knowledge on slope stabilization and landslides for every Engineer easily.

Keywords: Slope stabilization, Landslides, Soil erosion, Remedial Measures, Stabilization Techniques, Factor of Safety.

I. INTRODUCTION

Slope stabilization is very important for any civil and structural engineering and mining projects. If the slope stabilization is not good, it leads to failure and damage to the structure. This type of failures occurs due to bulk or heavy or large excavations and demolition of structures. So, any structure needs to maintain the stability of slopes. Using this, we can increase the design life or service life of the structure and minimize losses and damages to the structures. This selection of site plays an important role in the stability of the structure. It depends on the soil characteristics and soil conditions, and moisture content available in the soil. The geological formation is also one of the important factors for the selection of the site. But site selection is not also fully depending on the geological formation and depends on soil requirements.



Fig. Slope failure at mountainous places



Fig. Slope failure at Highways

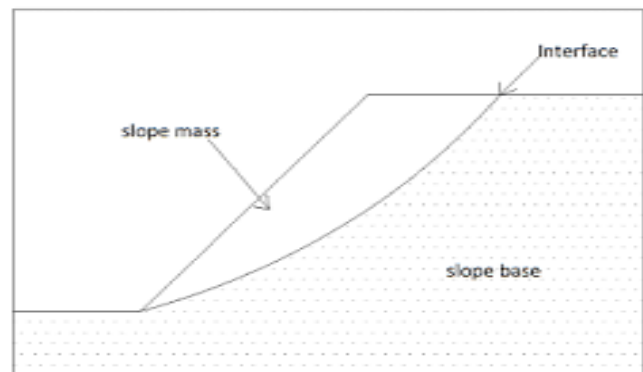


Fig. Slope mass

II. LITERATURE REVIEW

Pollok 2020 et al.

This Research Paper author explains landslide vulnerabilities, explains landslide reduction and consequences for landslides, and also explained the risks of landslide management. The author also explains landslide causing and affecting factors and mitigating factors and solutions for the landslide problems.

Pei Luen 2014 et al.

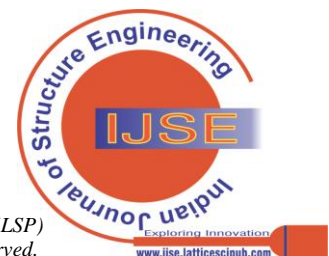
This paper explains the natural slope stability system and prevention and rehabilitation measures for landslides. This is also helpful for a stable ecosystem and risk management and reduction. Reduce the risks of landslides and increase the stability of slopes. This is also helpful to cost reduction and protection of human's lives. This author explains more about vegetation systems and also the functions of the eco system for landslides.

Manuscript received on 02 October 2021 | Revised Manuscript received on 23 October 2021 | Manuscript Accepted on 15 November 2021 | Manuscript published on 30 November 2021.

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III. METHODOLOGY

For soil stabilization, we need to conduct inspections and tests on the soil. In this, slope stabilization techniques are used to improve the stability of the slopes. There are different types of methods and techniques available for the stability of the slopes. This first one is based on geometric technique. It depends on the size and shape of the geometry and depends on change in the geometry shape, which may lead to the formation of slope failure in the structure. In this first cutting off and removal of unstable and weak material from the soil or rock slope. Then providing proper support to it. The second one is the hydrological methods. Which is depends on the availability of water content in the soil. If the water content in the ground or soil, then the structure will be weak, and it is subjected to fall because the stability of soil is very weak, and it loses the strength and bond between the soil. Then the soil subjected to collapse so that the structure will get damaged. Hence the proper treatment is necessary to avoid these hydrological problems in the soil or system. The third important technique is chemical and mechanical stabilization techniques. This increases the shear strength of the soil slope and minimizing external forces subjected to the slope failure.

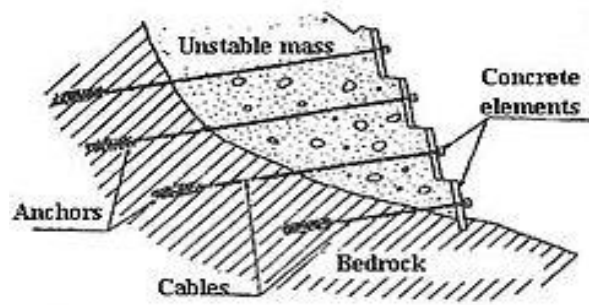


Fig. Stabilization of Landslide

SLOPE STABILIZATION TECHNIQUES

1. Geometrical Techniques

- The slope should be flat
- Reduce pore water or excessive water from the soil
- Eliminate weak parts of soil
- Replacement of the material
- Use of berms
- Compaction
- Drain pipes
- Drain holes
- Increase shear strength

2. Hydrological Techniques

- Use of surface drains
- Use of subsurface drains
- Use of inverted filters
- Freezing
- Heating

3. Chemical & Mechanical Techniques

- Use of grouting
- Gravity walls
- Cantilever walls
- Embankments
- Retaining structures
- Planting
- Shotcrete
- Reinforcement or steel support
- Removal of unstable material
- Ditches, Tunnels etc.

OBJECTIVES & USES

- Soil Stabilization
- Protection
- Removal of weak materials
- Support to the structure
- Water drainage
- Reduce water entry
- Control of groundwater movement
- Create new slopes
- Control erosion

Reasons for Slope failures

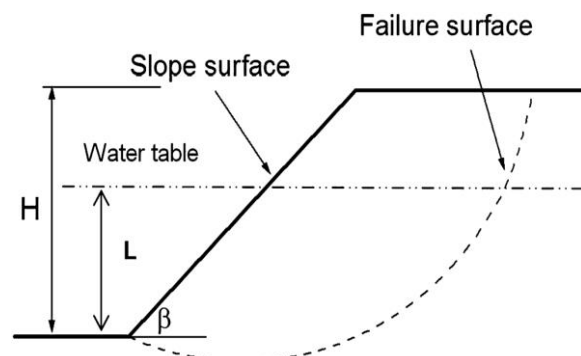
- Heavy rainfall
- Change in water levels
- Volcanoes
- Seepage
- Earthquakes
- External loads
- Sliding of mass
- Human-made activities

IV. APPLICATIONS

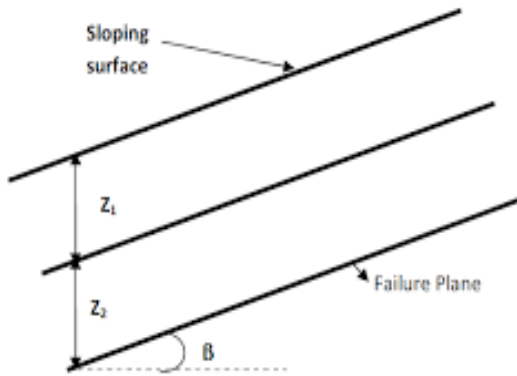
Most of the slopes are used for the construction of engineering works only. They are as follows;

- Construction of Highways
- Railways
- Canals
- Dams
- Embankments

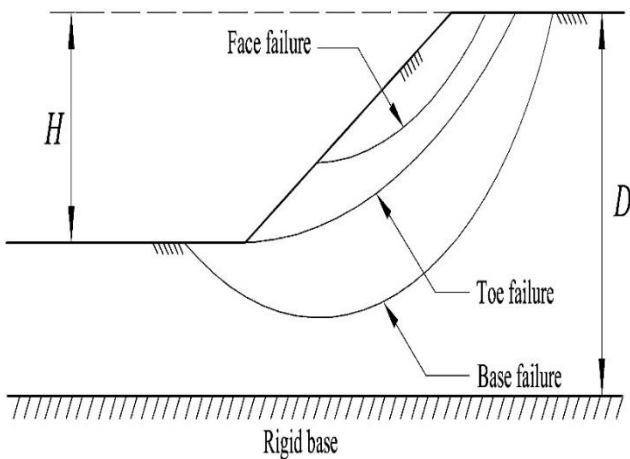
V. TYPES OF SLOPES



In this, there are two important types of slopes are there. This first one is finite slopes- in this type of slope, height is limited and is especially used for dams and embankments and excavations. This type of slope is constant.



The second important type of slope is infinite slopes- in this type, slope extends for long distances. In this failure of the slope is parallel to the surface of the slope. Similarly, based on resources, slopes are classified into two types: the first one is natural slopes- this type of slopes has occurred naturally along the geological path. The second important type of slope occurs due to human-made activities (human-made slopes). This type of slopes is occurred due to the cutting and filling of embankments.



There are three important types of slope failure. This first one is face failure. This type of slope failure occurs due to large angle. The second type of slope failure is toe failure. In this type of slope failure occurs due to steep slope and failure of surface passes through toe. The third and final type of slope failure is base failure. This type of failure occurs due to soil is very soft and toe is weak.

There are different types of methods are available for study and analysis of slopes. The common types of methods used for slopes are as follows;

- Swedish circle method
- Frictional resistance method
- Bishops' method
- Taylors's stability number

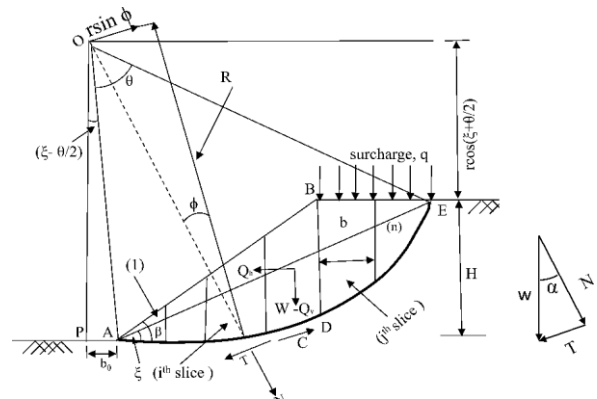


Fig. Swedish Circle

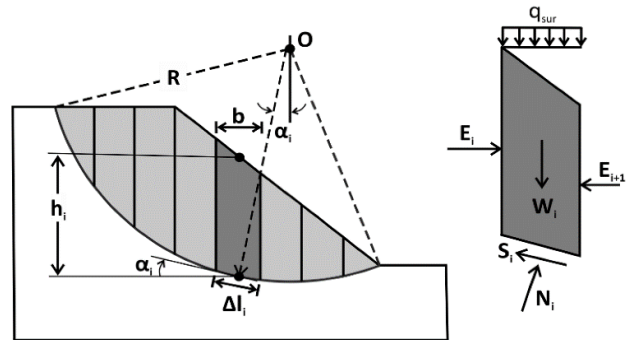


Fig. Bishops Method

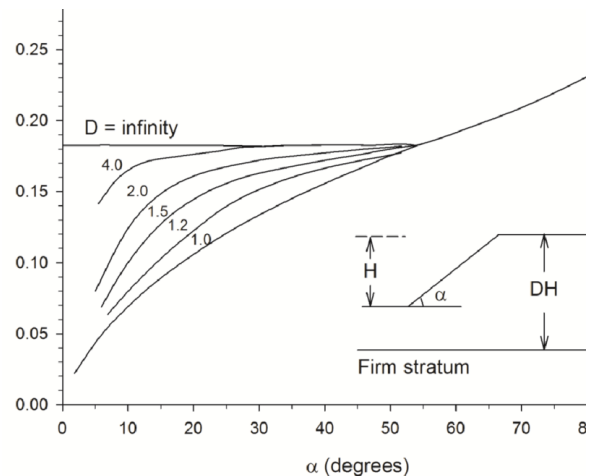


Fig. Stability Curves

REASONS FOR UNDERSTANDING ABOUT SLOPES

Every civil Engineer is must to know about basic knowledge on slopes because of the following reasons.

- To check the safety of slopes
- Determine the shear strength of the soil
- Check the water logging
- Check the soil is weak or strong
- Check the stability
- Check the ground water conditions
- Check the surface geology of soil
- To know the drainage conditions around slope



- To avoid sudden drawdown
- To avoid seepage problem
- To avoid percolation problem

VI. CONCLUSION

Every Engineer is must know about basic knowledge on slope studies and analysis. This analysis is helps to prevent future damages and loss of structure. This may help to save the cost, money and budget of the slope structure and also prevent accidental damages such as sudden fall of slopes. Determination of slope stabilization is required for safety for engineered structures and prevent future losses.

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