International Journal of Aquatic Science
ISSN: 2008-8019
Vol 13, Issue 01, 2021

Construction Techniques To Prevent Landslides

Janhavi Jaisingpure[1], Prof Ritesh Raut[2], Rutik Kale[3], Pritesh Ganjare[4], Hemant Chaudhari[5], Rupesh Misal[6], Ruchita Vairagade[7], Rahul Rathod[8], Prasad Kale[9]

[1]*Students, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India*
[2]*Professor, Dept. of Civil Engineering, J.C.O.E.T.,Yavatmal, Maharashtra, India*
[3]*Students, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India*
[4]*Students, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India*
[5]*Students, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India*
[6]*Students, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India*
[7]*Students, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India*
[8]*Students, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India*
[9]*Students, Dept. of Civil Engineering, J.C.O.E.T., Yavatmal, Maharashtra, India*

Abstract: ***Now a days, many landslides are occuring in hilly areas caused by rainfall, snowmelt, changes in water level, stream errosion, changes in ground water, earthquakes, volcanic activity,disturbance by human activities, or any combination of these factors. Landslides are among the most important and frequent natural calamites that cause severe socio-economic and human losses. After earthquake landslides are responsible for the greatest number of casualties and the largest amount of damage to man-made structures.***
In landslide areas, after assessing the risk level, the obligatory questions from communities, civil protection managers, and researchers are: What can we do? What should we do? What must we do? There are different strategies to reduce the vulnerability and risk: (a) Increasing the knowledge of the population, (b) Establishing an early warning system, and (c) selecting and constructing structures.
The aim of this chapter is to present the methodology to select stabilizing construction works to avoid a landslide, through the "valuation factors," which are parameters to assess the intrinsic and trigger instability factors (morphology, geology, hydrogeology, vegetation, rainfall, earthquake, erosion, human activity, etc.). The valuation factors are presented in graphs, equations, and tables; based upon them, the different construction works are selected, including (a) geometric adjusting for reducing destabilizing forces; (b) reinforcement elements, anchors, and pile barriers to increase the resistive forces; (c) drainage for eliminating surface runoff water or lowering the hydrostatic pressure; (d) retaining walls to support the horizontal pressure; and (e) surface protection to prevent rock falls and reduce erosion and infiltration.
This paper describe history, effects, causes, stabilization measures and effectiveness of these measures.

Keywords: Landslides, Construction Works, Valuation Factors, Structural Supports.

1. INTRODUCTION

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity. While the definition of a landslide, which states that it is a slide of large mass of dirt and rock downhill, may make it seem pretty simple, a look at the aftermaths of this natural disaster puts forth a gruesome picture of the same. The landslides occurring on steep slopes tend to move rapidly and are therefore more dangerous than other landslides. Major landslides that occurred in India reflect that they are concentrated in hilly regions of Himachal Pradesh, Uttarakhand, and the northeast Himalayan region.

The landslides often cause disasters and damage to people and their properties at the mountainous areas around the world; these disasters cause casualties and economic losses, such as housing, infrastructure, public services, roads, bridges, hospitals, etc., and the interruption of the normal activities of the region, such as agriculture, livestock, commerce, tourism, financial transactions, etc. A fundamental problem to solve is to make the investments for reconstructing and rehabilitating the destroyed places, which must be obtained from other social investment programs, donations from other countries, and/or sources of external financing that lead to indebtedness and impoverishment of communities, regions, or countries. The rational solution to landslide problem is to relocate exposed and vulnerable people to secure sites, but acquiring land in mountainous regions is very difficult; besides the majority of population is rooted to its origin place, and it cannot be relocated so easily.

A landslide is the mass movement of rock, soil, and debris down a slope due to gravity. It occurs when the driving force is greater than the resisting force.It is a natural process that occurs in steep slopes. The movement may range from very slow to rapid. It can affect areas both near and far from the source.

1.1 OBJECTIVE

- Study of Existing techniques to avoid land sliding.
- Suggestions of cost efficient techniques as per site condition.
- Study of Modern Techniques to be adopt in India.
- Analysis of new techniques used over world wide
- Introducing effective techniques against landslide.
- Introduce new techniques that will be more convenient than the old techniques.

2. LITERATURE REVIEW

2.1 Landslide evaluation Virginia Coastal Plain January 1998

AUTHOR : R.E. MartinJ J. Seli

- Geotechnical characterization, analysis and recommended remedial solutions are presented for two landslides. One of the landslides occurred in stiff Coastal Plain clays north of Richmond. The second slide occurred in sediments of the York River near Yorktown, Virginia. In the case of the Richmond slide, a small excavation for an access roadway was cut at the base of a natural slope and this triggered movement well up the slope, threatening several residences located at the top of the slope. In the case of the York River slide, pile driving activities for a pier caused instability of slope transversing the existing pier. Remedial repairs and lessons learned from both slides are discussed.

[2.2]According to Stabilization Measure Adopted for Controlling Landslide: A Case Study of Upper Mai Hydroelectric Project

AUTHOR : Kanchan Chaulagai

- Stability is the key issue in landslide stabilization. Methodology and component adopted in stabilizing the slide play vital role in this regards. In many occasion, stability measure adopted for controlling slide has been found to be unsuccessful, inadequate causing not only the safety risk but also huge economic loss. This paper describe history, effects, causes, stabilization measures and effectiveness of these measures played for controlling landslide of headwork area of Upper Mai Hydroelectric Project. The pioneering solution applied for landslide stabilization such as application of rock bolts, shotcrete and water management found to be highly effective in controlling the landslide. The Upper Mai Hydroelectric Project is a run-of-river (RoR) type project located in Mabu Village Development Committee of Ilam District in Nepal. Stabilization measure are used in Structural Supports, Retaining Wall, Rock Bolts, Shotcreat. Stabilization measure adopted for protection of the slide slope with conventional type always does not give successful results. The pioneering solution applied for landslide stabilization such as application of rock bolts, shotcrete and water management is found to be highly effective in controlling the slide of Upper Mai Hydroelectric Project. The Upper Mai HEP case also illustrates that application of rock bolts, shotcrete in landslide area is not easy task, and its cost is very high comparing to other stability measures that were generally applied.

[2.3] Spatial variability of mass movements in the Satluj Valley, Himachal Pradesh during 1990 ~ 2006

AUTHOR : Vikram Gupta

- Satluj Valley is known to have a history of landslides and related mass movement activities since the geological times. Geological and geomorphological settings combined with anthropogenic activities constitute a propensity towards slope failure. During the last two decades, the area witnessed substantial increase in athropogenic pressure, mainly due to the exploitation.

[2.4] Landslide hazard zonation using GIS: A case study from Sindhupalchowk, Nepal

AUTHOR : Tri Dev Acharya

- Landslides are instant event of mass movement of earth surface down a slope, causing loss of life and property in hilly region of Nepal. Considering the recent massive landslide event, development of the landslide hazard map of Sindhupalchowk district was done using different weighted controlling factors i.e. slope, relative relief, distance to road & river network, landuse and soil maps. Landslide zone of low, moderate, high and very high hazards were derived and found that around 40% are in high hazard prone areas. Prior identification of hazard area could mitigate future loss events.

[2.5] Learning in an Interactive Simulation Tool against Landslide Risks: The Role of Strength and Availability of Experiential Feedback

AUTHOR : Pratik Chaturvedi, Akshit Arora, Varun Dutt

- Feedback via simulation tools is likely to help people improve their decision-making against natural disasters. However, little is known on how differing strengths of experiential feedback

and feedback's availability in simulation tools influence people's decisions against landslides. We tested the influence of differing strengths of experiential feedback and feedback's availability on people's decisions against landslides in Mandi, Himachal Pradesh, India. Experiential feedback (high or low) and feedback's availability (present or absent) were varied across four between-subject conditions in a tool called the Interactive Landslide Simulation (ILS): high damage with feedback present, high damage with feedback absent, low damage with feedback present, and low damage with feedback absent. In high-damage conditions, the probabilities of damages to life and property due to landslides were 10 times higher than those in the low-damage conditions. Furthermore, only high-damage feedback produced learning in ILS. Simulation tools like ILS seem appropriate for landslide risk communication and for performing what-if analyses.

3. METHODOLOGY TO BE ADOPTED IN INDIA :

3.1 Constructing piles and Retaining walls :

Piles are metal beams that are either driven into the soil or placed in drill holes. Properly placed piles should extend into a competent rock layer below the landslide. Because landslides can ooze through the gaps between the piles, retaining walls are often constructed. Retaining walls can be constructed by adding lagging (metal, concrete, or wooden beams) horizontally between the piles. Such walls can be further strengthened by adding tiebacks and buttressing beams. Tiebacks are long rods that attach to the piles and to a competent rock layer below the ground surface. Buttressing beams are placed at an angle downslope of the piles to prevent the piles from toppling or tilting. Retaining walls also are constructed of concrete, cinder blocks, rock, railroad ties, or logs, etc.

3.2 Slope Vegetation :

One of the quickest and easiest ways to prevent a landslide on a slope is to vegetate it. This landslide prevention method works best on slopes that are not too steep or if the movement hasn't already begun. You can do this method yourself by planting a groundcover or hire a landscaper to vegetate the slope. Trees, grasses, and vegetation can minimize the amount of water infiltrating into the soil, slow the erosion caused by surface-water flow, and remove water from the soil. Although vegetation alone cannot prevent or stop a landslide, removal of vegetation from a landslide-prone slope may initiate a landslide.

3.3 Excavating The Head :

Removing the soil and rock at the head of the landslide decreases the driving pressure and can slow or stop a landslide. Additional soil and rock above the landslide will need to be removed to prevent a new landslide from forming upslope. Flattening the slope angle at the top of the hill can help stabilize landslide-prone slopes.

3.4 Buttressing The Toe :

If the toe of the landslide is at the base of the slope, fill can be placed over the toe and along the base of the slope. The fill increases the resisting forces along the failure surface in the toe area. This, in turn, blocks the material in the head from moving toward the toe. However, if the toe is higher on the slope, adding fill would overload the soil and rock below the toe, thus causing a landslide to form downslope of the fill.

3.5 Rock Fall Protection :

Rock falls are contained by ditches at the base of the rock exposure, heavy-duty fences, and concrete catch walls that slow errant boulders that have broken free from the rock outcrop. In some cases, loose blocks of rock are attached to bedrock with rock bolts, long metal rods that are anchored in competent bedrock and are threaded on the outside for large nuts. A metal plate with a center hole, like a very large washer, is placed over the end of the rod where it extends from the loose block, and the nut is then added and tightened. Once constructed, remedial measures must be inspected and maintained. Lack of maintenance can cause renewed landslide movement.

3.6 Diverting Debri Pathways :

Building pathways to divert debris is another option to prevent landslides on your property. You can create these pathways with the help of retaining walls. However, if you build walls to divert debris flow and then that flow lands on a neighbor's property, you can be liable for damage.

3.7 Temporary Prevention :

For temporary landslide prevention, sandbags can be used to divert water from uncontrolled spilling just as retaining walls or diverted pathways do. Another method is to protect unstable areas with plastic sheeting, tarps or even burlap, especially in areas without vegetation because of recent fires.

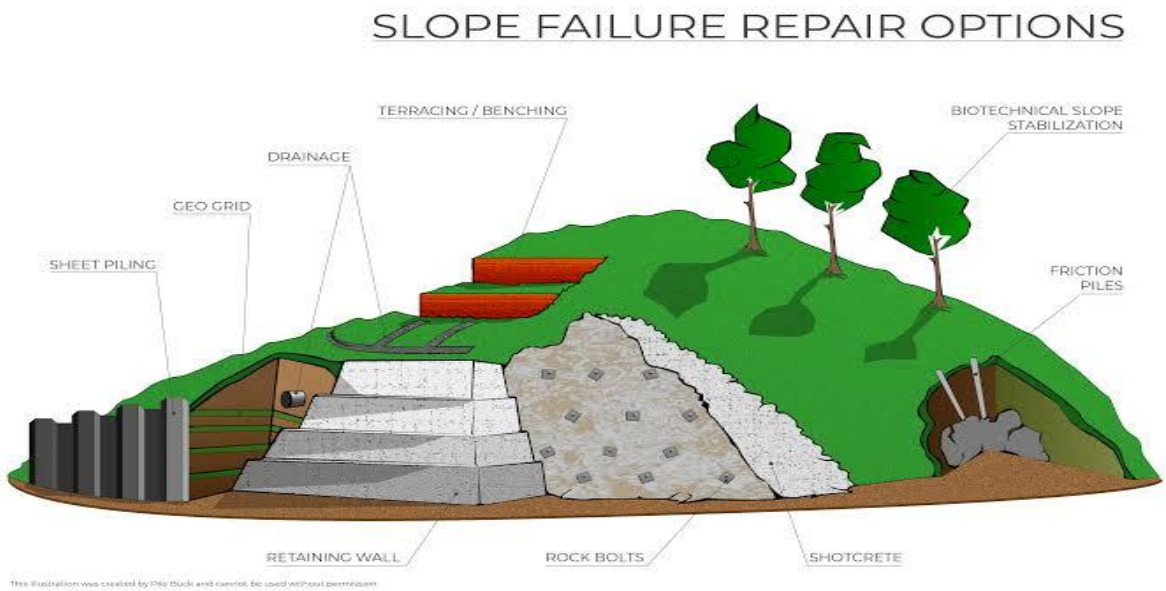

Fig No.1 Slope Failure Repair Options

4. METHODOLOGY TO BE ADOPTED IN GLOBAL :

A landslide can occur when earth, soil or rock can no longer hold itself up and gives way to gravity due to earthquakes, volcano or rainfall. Landslides can move slowly or quickly with disastrous effects. To prevent landslides on your property, there are a few things you can do both temporarily and permanently. Keep in mind that if a landslide threatens your home, you should evacuate immediately.

4.1 REAL TIME OF ACTIVE LANDSLIDE :
Techniques used for early landslide warning are largely phenomenological, relying on surface measurements of displacements over time. Most monitoring is carried out through repeat geodetic surveys of monitoring prisms, which provide precise data on magnitudes and rates of horizontal and vertical ground movements.

Fig No.2 Landslides Mitigation Slope Protection With Gabion Retaining Wall

4.2 REAL TIME OF ACTIVE LANDSLIDE :
Techniques used for early landslide warning are largely phenomenological, relying on surface measurements of displacements over time. Most monitoring is carried out through repeat geodetic surveys of monitoring prisms, which provide precise data on magnitudes and rates of horizontal and vertical ground movements.

4.3 GABION WALLS -WIRE MESH FILLED WITH BOULDER :
The combination of the Implant Deterrence Piles and Implant Retaining Walls will prevent landslide caused by massive earthquakes and torrential downpour. The piles embedded into stable ground hold soils and allow excessive ground water to flow down through pile gap. The Gabion retaining walls act as a mass gravity structure providing stability to slopes against debris fall. The retaining walls provide support to the slopes by resisting lateral movement and pressure. Gabion retaining walls can be as high as 30 feet.

4.4 ROCK BOULTING :
Rock bolts work by ‘knitting’ the rock mass together sufficiently before it can move enough to loosen and fail by unraveling (piece by piece). Unlike common anchor bolts, rock bolts can become ‘seized’ throughout their length by small shears in the rock mass, so they are not fully dependent on their pullout strength.

4.5 GEOGRID :
A Geogrid is geosynthetic material used to reinforce soils and similar materials. This fact allows them to transfer forces to a larger area of soil than would otherwise be the case. Geogrids

are commonly made of polymer materials, such as polyester, polyvinyl alcohol, polyethylene or polypropylene.

4.6 BIOTECHNICAL SLOPE STABILIZATION

Combined use of vegetation and man-made structural elements Working together in an integrated manner (upper). Vegetation planting combined with rock counterfort Construction (lower). Vegetation has both hydrological and mechanical beneficial effects.

4.7 SHOTCRETE

Shotcrete can be applied by two distinct application Techniques, the dry-mix process and the wetmix Process. Decisions to use the dry or wet mix shotcreals. Process are usually made on a site-by-site basis. Due To the inaccessibility of site for transportation and also Equipment available at the site of contractor, dry mix System was adopted.

4.8 FLEXIBLE DEBRIS-RESISTING BARRIERS

Flexible barriers, which are mainly formed of steel ring nets mounted between horizontal steel ropes spanning between steel posts and anchored into the ground, are one of the techniques that can be used to mitigate natural terrain landslides. The advantages of flexible barriers are that they are relatively easy to install on steep natural terrain, less visually obtrusive and have less impact compared with reinforced concrete barriers. Whilst flexible barriers have been in use for over twenty years asba protective measure against boulder falls and rock falls, the application of flexible barriers for resisting the impact of natural terrain landslide debris is a relatively new concept.

SOME TECHNIQUES

- Surface drains to divert water from flowing onto the slide area (collecting ditches and pipe).
- Vertical (small diameter) boreholes with pumping or self draining
- Crib-block walls
- Caissons
- Cast-in situ reinforced concrete walls Reinforced earth retaining structures with strip/ sheet – polymer/metallic reinforcement
- Protective rock/concrete blocks against erosion
- Internal slop reinforcement
- Micropiles
- Anchors (prestressed or not)
- Stone or lime/cement columns
- Heat treatment
- Freezing
- Electroosmotic anchors
- Construction of buttress counterforts of coarse-grained materials during landslide remediation during highway construction

5. CONCLUSION :

Landslides are a dangerous hazard that can cause serious damages, death, injuries and affect a variety of resources. By understanding the different types and causes of landslides it can help us predict future occurrences and reduce the potential effects. This paper has provided information about various types of landslides, some new techniques adopted to prevent land slide and also to provide knowledge and understanding of landslide phenomena and processes that will enable problem-solving and allow projects to be carried out.

In this paper we are studied by using new techniques by replacing existing techniques are more Effective as well as can be adopted with economical.

6. REFERENCE :

[1] Ky.chois, Raymond w m. chung, Landslide disaster prevention and mitigation through works in hongkong: journal of Rock machnics and geotechnical engineering 5[2013] 354-365

[2] Andrés Cuanalo Camposhttp://dx.doi.org/10.5772/intechopen.70797Landslides: Methodology to Select Stabilizing Construction Works

[3] Assessment of landslide-induced damage to structures: the Agnone Landslide case study (southern Italy) Bulletin of Engineering Geology and the Environment (2019) 78:2387–2408 https://doi.org/10.1007/s10064-018-1303-9

[4] Author : Kanchan Chaulagai Mai Valley Hydropower Private Limited, 2009, Upper Mai Hydroelectric Project (9.98 MW): Design Report, Volume 1- Main Report, pp. 21-41.

[5] Mai Valley Hydropower Private Limited, 2013, Upper Mai Hydroelectric Project: Tunnel Inspection Report, pp.14-17.