
02 Jun 1988, 10:30 am - 3:00 pm

Control of Surficial Slides by Different Erosion Control Techniques

T. K. Natarajan

Central Road Research Institute, New Delhi, India

A. V. S. R. Murty

Central Road Research Institute, New Delhi, India

Deep Chandra

Central Road Research Institute, New Delhi, India

Follow this and additional works at: <https://scholarsmine.mst.edu/icchge>



Part of the [Geotechnical Engineering Commons](#)

Recommended Citation

Natarajan, T. K.; Murty, A. V. S. R.; and Chandra, Deep, "Control of Surficial Slides by Different Erosion Control Techniques" (1988). *International Conference on Case Histories in Geotechnical Engineering*. 12. <https://scholarsmine.mst.edu/icchge/2icchge/2icchge-session3/12>

This Article - Conference proceedings is brought to you for free and open access by Scholars' Mine. It has been accepted for inclusion in International Conference on Case Histories in Geotechnical Engineering by an authorized administrator of Scholars' Mine. This work is protected by U. S. Copyright Law. Unauthorized use including reproduction for redistribution requires the permission of the copyright holder. For more information, please contact scholarsmine@mst.edu.

Control of Surficial Slides by Different Erosion Control Techniques

T.K. Natarajan

Deputy Director, Central Road Research Institute, New Delhi, India

A.V.S.R. Murty

Central Road Research Institute, New Delhi, India

Deep Chandra

Central Road Research Institute, New Delhi, India

SYNOPSIS

Many natural and embankment slopes fail due to the erosion of the top surficial soil mantle. Denudation of vegetation from soil slopes combined with the further steepening of slopes due to natural and man-made causes such as cuts result in such a type of failure. Essentially, the corrective measures appropriate for stabilizing these slopes comprise erosion control by establishing vegetation on the slope. The methods of vegetative turfing include asphalt mulch, coir/jute netting, geogrids and stone apron techniques. The paper sets forth the case history giving details of some of the relatively new techniques for erosion control on a hill road in India and evaluates the relative performance and the relative economics of these methods.

INTRODUCTION

Landslides are difficult to analyse due to the complexity of geologic settings and variation in the type of materials involved. Landslides can occur slowly or suddenly, with or without apparent provocation.

External disturbances such as undercutting the foot of an existing slope or digging an excavation with unsupported sides can cause slides. Some times slopes which are stable for a long time, suddenly fail due to deterioration in the strength of the soil or a temporary increase in run-off water on the surface or an increase of seepage water into the soil mantle. The increased weight of soil from an increased degree of saturation owing to heavy rainfall often starts a slide in humid regions.

Most 'surficial landslides' occur as a result of denudation of vegetation on the hill slopes. Vegetative turfing represents one of the most important corrective measures in either case of landslides caused by run-off water or by seepage of water into the soil mantle causing a deep seated landslide (Ref. 1). In hill roads bristling with actual or potential landslide problems, there is a strong case for undertaking systematic treatment of all denuded soil slopes along the hill road with a view to establishing vegetative turfing. Based on experience with several field trials carried out by the Central Road Research Institute, the above technique has been developed and sponsored for the treatment of erodible slopes as part of landslide corrective measures to be used either singly or in combination with other techniques.

The CRRRI had undertaken a field trial using this technique in combination with other techniques of surface drainage at one of the landslide spots in the Nilgiri hills in Tamilnadu in South India. The paper attempts to bring out the effectiveness of the different techniques vis-a-vis their relative costs for a proper evaluation of their techno-economic benefits.

SITE INVESTIGATION

The Nilgiris in the Western Ghats are known to be susceptible to landslides. Many landslides occurred in this region during 1978-79. The landslides in the Nilgiri district in 1978-79 caused heavy damages in the District. Extensive field studies

conducted in this area have shown that the rocks in the Nilgiris area are of deep-seated metamorphic origin (Ref. 2). The bed rocks comprise mainly charnokites with lateritic soil forming a thick cover over them. Field observations indicated a build-up of excess hydrostatic pressure within the slope at certain places due to heavy rains. The causes include seepage of excess rain water into the soil mass combined with deformation of the hill slopes. After a careful study of the failure mechanism, it was concluded that if the excess hydrostatic pressure built-up in the soil mass is relieved and the phreatic surface maintained at an acceptable level, the slope would remain stable. In order to reduce seepage of rain water, vegetative turfing by coir/jute netting and asphalt mulch technique or stone apron were considered suitable in combination with horizontal drains to drain out the excess subsoil water that had already seeped into the body of the slope. A brief description of the techniques are given in the following paragraphs.

SLOPE TREATMENT BY COIR/JUTE NETTING

The Slope area proposed to be treated (Fig.1) is demarcated and graded to a uniform slope by raking the top soil for about 2 to 5 cm. The root stumps and sharp objects are removed from the area to be treated so that the netting gets a proper seating on the soil surface. Then the first seeding @ 5 kg per acre is done and dibbling of root slips of the locally available grass (willow grass) is also done. The root slips are planted, 15cm apart, in both directions, on a square pattern. The tops of the root slips are removed before dibbling. After this operation, tamping by wooden rammers is done to obtain a smooth surface and achieved appropriate compaction of the seed and the root slips and to ensure even sowing. Thereafter, coir/jute netting of 2.54 cm square openings having a width 1.22m is laid on the prepared surface firmly in the direction of flow (Fig. 2). The different widths of coir netting already rolled out are secured against displacement by making them overlap by 8 cm and pegging them down into the slope with hair-pin-shaped steel staples. The top and bottom ends of coir/jute netting are firmly anchored in 30 cm deep trenches fully stretched. The net provides innumerable miniature "check dams" absorbing the impact and the kinetic energy of the falling rain. The soil, seeds and root slips are kept in their respective place without being dislodged. The coir/jute netting disintegrate after the first rainy season and adds to the humus content of the soil. The

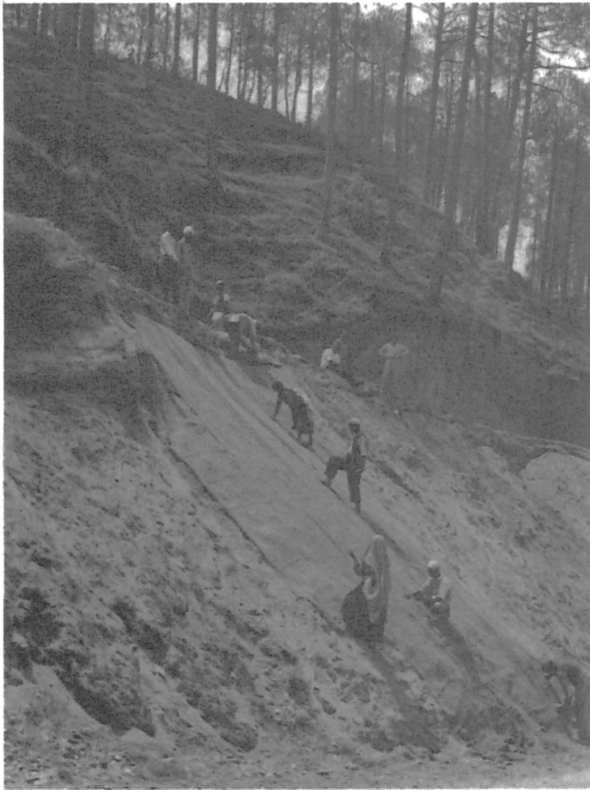


Fig.1: Preparation of the Slope for Erosion Control Measure.

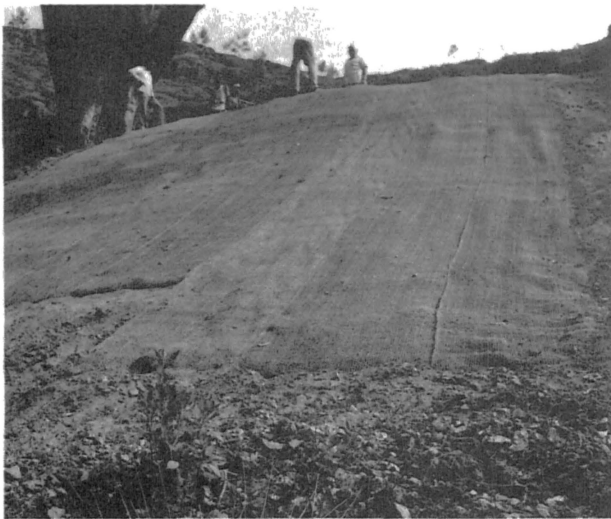


Fig 2: Coir netting in position on the hill slope.

seeded and sprigged vegetation (Fig.3) forms a turf covering the hill slope and serves to protect the slope from subsequent erosion.

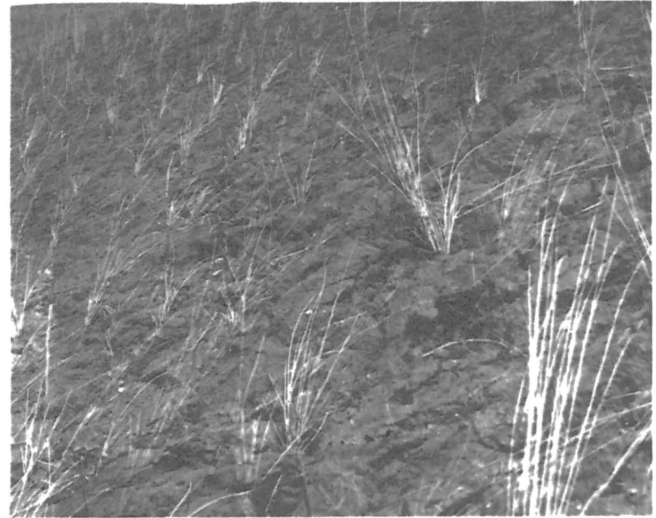


Fig. 3: Growth of Vegetation on the hill slope.

As in the earlier method, the proposed area to be treated is prepared in to vast seed beds. The root slips of the most promising local grass (willow grass) is dibbled, 15 to 20 cm apart from root to root and row to row, taking care to see that no tufts or clumps are dibbled. An asphalt-emulsion (mulch) of a specified grade is then spread by a suitable sprayer (Fig. 4) so that the emulsion is sprayed



Fig. 4: Spraying of Bituminous Emulsion on the Slope.

gently and uniformly all over the treated area. The optimum rate of application of emulsion coating is about 0.90 ltr. per sq.m. so that a thin layer (film) is formed over the entire treated area. This optimum rate of emulsion spraying is maintained as the thicker application would tend to retard the growth of the vegetation.

The emulsion film gradually disintegrates and its place

is as gradually taken up by a green vegetative carpet (Fig. 3). The emulsion film acts as an immediate cover for the slope and retain the soil moisture till the vegetation takes root. To augment the lack of nutrients in the soil and to reduce the acidic nature of the soil, calcium ammonium nitrate is applied to the soil at the rate of 50 kg per 1000 sq.m. (Ref. 2 & 3), if at all considered necessary.

PROVISION OF STONE APRON FOR EROSION CONTROL

Erosion control on the hill slope can also be achieved by

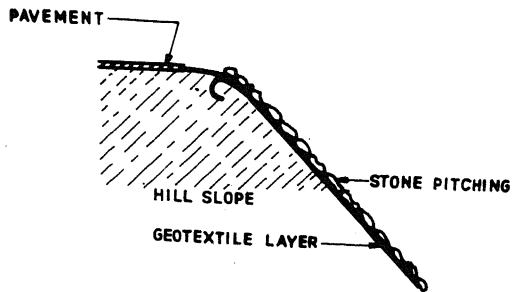


Fig. 5 : Protection of Hill Slope by Stone Apron

providing a stone apron on the soil slope to be protected.

The apron consists of a geogrid or geotextile providing a protective cover over the slope subjected to run off. The fabric due to its high filtration characteristics allows the water to flow out, while at the same time retaining the soil. In situations where a continuous sheet of flowing water is involved, fabric protection of the underlying soil by itself, is not sufficient. The current involved will eventually undercut the soil beneath the fabric and tend to dislodge it, rendering the soil base exposed and making it susceptible to erosion. In most cases, stone pitching is required over the fabric to keep the fabric in place, Fig. 5 to improve the efficiency of the controlling measures. When the velocity of run off water is not very high, slope erosion can be controlled by mere stone pitching without the fabric. When a geotextile is used, proper precautions should be taken to protect the geotextile from damages before and after laying, (Ref. 4).

DISCUSSION

The above mentioned erosion control measures are invariably applied for controlling surficial erosion of slopes, both natural and man-made. These measures are to be conjointly supplemented by other remedial measures such as providing surface & subsurface drainage systems when the job is one of the controlling deep-seated slides.

Erosion control measures including both the asphalt mulch technique and the coir netting technique have been tried out on a large scale for the control of surficial slides in the Nilgiri hills. Experience with these methods has shown growing a vegetative turfing of willow grass to be more effective than the mere planting of big trees. The willow grass tends to cover the surface more uniformly and anchors down the soil mantle more firmly. The cost aspects of the different methods of treatment tried out in the Nilgiri hills are set out in Table 1.

An analysis of the experience gained from these field trials involving different methods of slope treatment together

**TABLE I
COMPARATIVE COST DATA OF DIFFERENT EROSION CONTROL TECHNIQUES**

S.No.	Technique	Area Sqm.	Cost of material Rs.	Labour Charges Rs.	Over- head charges Rs.	Total cost Rs.	Remarks if any
1.	Asphalt Mulch Technique	100	500/- (\$41)	1000/- (\$83)	500/- (\$41)	2000.00 (\$167)	
2.	Coir Netting	100	550/- (\$46)	1000/- (\$83)	100/- (\$8)	1650/- (\$137)	
3.	Jute Netting	100	650/- (\$54)	1000/- (\$83)	100/- (\$8)	1750/- (\$145)	
4.	Netlon	100	5800/- (\$483)	1000/- (\$83)	100/- (\$8)	6900/- (\$574)	
5.	Apron without geotextile	100	1500 (\$125)	1300/- (\$108)	200/- (\$17)	3000/- (\$250)	
6.	Apron with geotextile	100	3500/- (\$292)	1300/- (\$108)	200/- (\$17)	5000/- (\$417)	

Note: Cost of each technique is approximate, based on Indian CPWD & other market rates as in August, 1987. (Exchange rate at 12 Indian Rupees per US Dollar)

with the cost data as reflected by Table 1 point to the following conclusions:

CONCLUSIONS

1. Vegetative turfing is an effective tool for the treatment of surficial slides. However, for deep-seated slides, it would prove effective only when used in combination with other measures (like surface drainage and subsurface drainage) designed to control the landslides.
2. In India, where coir/jute is plentifully available and are relatively inexpensive, coir/jute netting techniques deserve to be used extensively, for purposes of erosion control.
3. From the point of view of limits of application of the different techniques, it would seem that the asphalt mesh technique would suffice for erosion control problems obtaining in areas of moderate rainfall whereas the technique of coir/jute netting would be more suitable for tackling problems of erosion control in areas of heavy rainfall. It logically follows that geogrids made of polypropylene can always be used instead of coir/jute netting in many situations, provided it proves to be cost-effective.

ACKNOWLEDGEMENT

This paper is published with the kind permission of the Director, Central Road Research Institute, New Delhi-110020.

REFERENCES

1. Mehra, S.R. Natarajan, T.K. (1966): Handbook on Landslide Analysis and Correction.
2. CRRRI (1981) Report 'Field Trials on the Installation of Horizontal Drains near Ooty in Nilgiris.'
3. Natarajan, T.K. Gupta S.C. (1980) "Techniques of Erosion Control for surficial Landslides" Proc. International Symposium on Landslides" New Delhi-India.
4. Natarajan, T.K., Murty, AVSR (1985) "Geotextiles in Erosion Control Works for Landslide Correction" Seminar on Construction of Roads in Hill Areas: Nainital, India.