

REMEDIAL MEASURES FOR CONTROLLING LANDSLIDES

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Landslides or slope failures are major problems in many parts of the world due to the high susceptibility of slope forming material to sliding. The interference of sliding movements of varied character with the activities of human beings, such as mining, tunnelling, road works and other civil engineering construction works, generally results in excessive damage to life and property. Many remedial measures are now being used in stabilising these slopes with a view to control or arrest such hazardous effects.

The stabilization of slopes is regarded as a two phase solution. It can be used as a preventive measure against failure or as a corrective measure after failure. Whatever the nature of solution the success of remedial measures entirely depends on the accurate diagnosis of the problem.

In the design of most effective and economical stabilization method for a particular slope, a thorough understanding of the following factors will be of useful assistance.

- type of movement involved
- type of material involved
- causes of failure
- geological environment.

Sliding phenomena involves such a variety of processes and disturbing factors that they afford unlimited possibilities of classification. The material involved in these failures is basically soil or rock. According to the geomechanical character and the velocity of movement different

sliding phenomena such as falls, topples, slides and flows are distinguished in slope failures.

Slope movements occur because the forces creating movement, the disturbing forces, exceed those resisting it, the resisting forces, that is the shear strength of the material concerned. The actions by natural and human agencies can cause a reduction of resisting forces or an increase in disturbing forces to increase the risk of failure of a particular slope.

On the other hand, the remedial measures used in the stabilization of slopes are expected to increase the resisting forces and/or to reduce the disturbing forces to ensure a greater degree of stability for the slope concerned.

There is no unique solution to all types of failures, but a wide range of techniques are available in stabilising all types of slopes. The selection of most suitable remedial measure will be greatly influenced by the location of slope and the economic factors in addition to the factors already mentioned.

A summary of stabilization techniques is given below:

I. Excavation Methods:

- (a) Removal of head
- (b) Loading of toe
- (c) Benching of slope surface
- (d) Flattening of slope surface

II. Vegetation Methods:

- (a) Growth of water - loving trees

- (b) Vegetative turfing with binding material
- (c) Terracing

III. Drainage Methods:

- (A) Surface Drainage
 - (a) surface ditches
 - (b) slope treatment
 - (c) sealing of cracks

- (B) Sub-surface Drainage
 - (a) Horizontal drains
 - (b) Vertical drains
 - (c) Drainage Trenches

IV. Restraining Structures:

- (a) Buttresses
 - rock fill
 - earth fill
- (b) Cribs or Retaining walls
- (c) Piling
- (d) Slope paving
- (e) Anchoring

V. Miscellaneous Methods:

- (a) Grouting
- (b) Thermal Treatment
- (c) Electro - osmosis
- (d) Chemical Treatment