SLOPE STABILIZATION USING VETIVER GRASS

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INTRODUCTION

- Erosion is the process of soil disintegration into which soil dislocate from one location to another location by the action of wind and land slide and by gravitation action. Due to erosion on hilly areas stability of soil decreases.
- Uttrakhand where the occurrence of land slide is much more and the soil grain properties of uttrakhand location are erodible. Cloud busting in uttrakhand site are much more prone.
- These disaster lead to soil erosion of river bank, slope on hilly area, road slope. There are many technique for slope stabilization but they are costly and not beneficial for environmental also.
- Uttarakhand is a zone 4 area for earthquake where the occurrence of the landslide is much more and heavy quantity of disaster takes places. Annual rainfall is about 1405 mm of Pantnagar and annual rainfall of Dehradun is about 1875 mm.

- Vetiver grass on slope is very effectively for slope stabilization and environment friendly. Root of vegetation play effect role in increasing the stability of slope which may be artificial or natural slope.
- Vetiver grass can reduce the soil erosion and can control many types of natural disaster, including landslide, road slope stability, erosion, and mudslide.
- The root dissemination in the soil is effected by the climatic locales and the soil hydrological properties, especially in the areas where the plant-development happens in water-restricted conditions and the mechanical quality parameters of the root-soil arrange is affected by the quality of the single root, quality of the soil, strength of soil, root dispersion in the soil and the quality at the interface of the soil and the root
- The conversion from intermittent supply systems to continuous supply systems is anticipated to reduce the overall costs as well as improve water quality and water availability, thereby reducing the loss and wastage as well. However, there is no significant evidence to prove this.

Causes of slope failure

- Stability of slope is dependent on topography, geological and climate.

- Slope failure when the value of shear stress equal or exceed to strength of soil then critical sliding occur.

- Factor of safety depends on the ratio of shear strength to shear stress. Any variable that increase in shear stress which result in decrease in strength of soil by which slope movement occur.

Causes of slope failure

Increase in shear stress	Decrease in shear strength
Structure and fills at top	Increase in pore water pressure, reduces effective stress
Removal of lateral support	Causes swelling in soil
Rapid change in volume of water	Weathering and physiochemical degradation
Increase in lateral stress	Failure in shear strain
Earthquake loading	

Mechanism of soil erosion

- Causes of soil erosion depends on –

(a) Soil grain interlocking

(b) Particle size

- When the fluid passing over soil surface then Drag force excreted by the fluid and resisted by cohesiveness value of soil grain.

- Erosion caused by drag force which are developed from velocity, discharge, particle and roughness value of soil grain.

- Erosion protection consist of –

(a) To decrease the drag force by the dissipating the fluid energy or decrease the velocity of fluid.

(b) Increases the resistance between the particles with the help of reinforcing the soil by which increasing particle bond strength between them.

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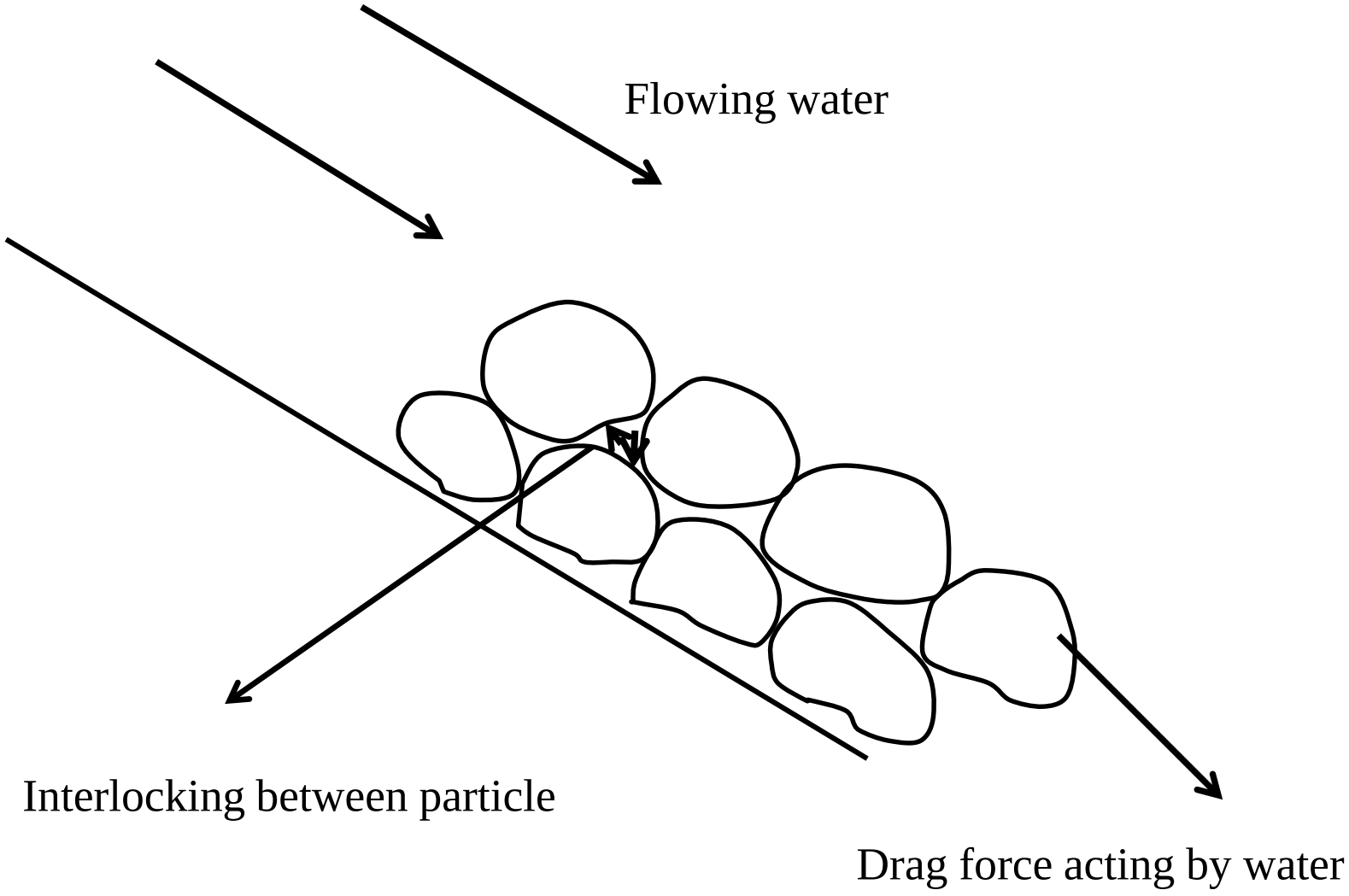
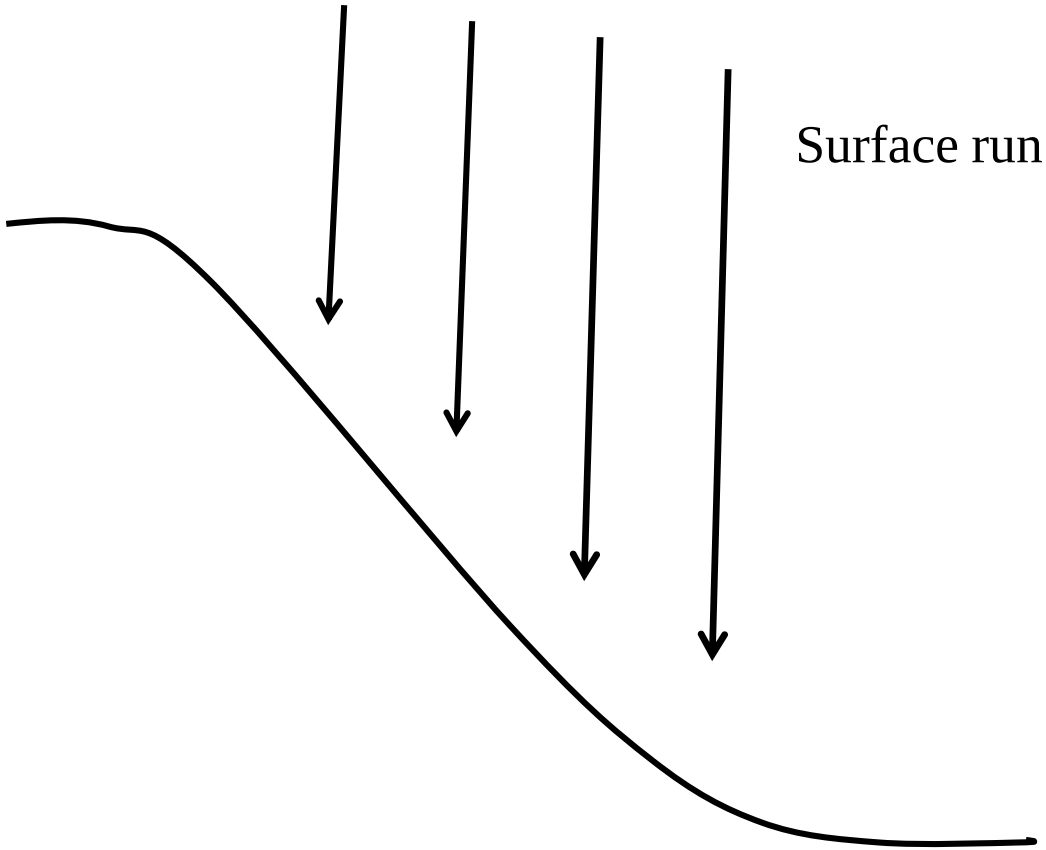
Mechanism of soil erosion



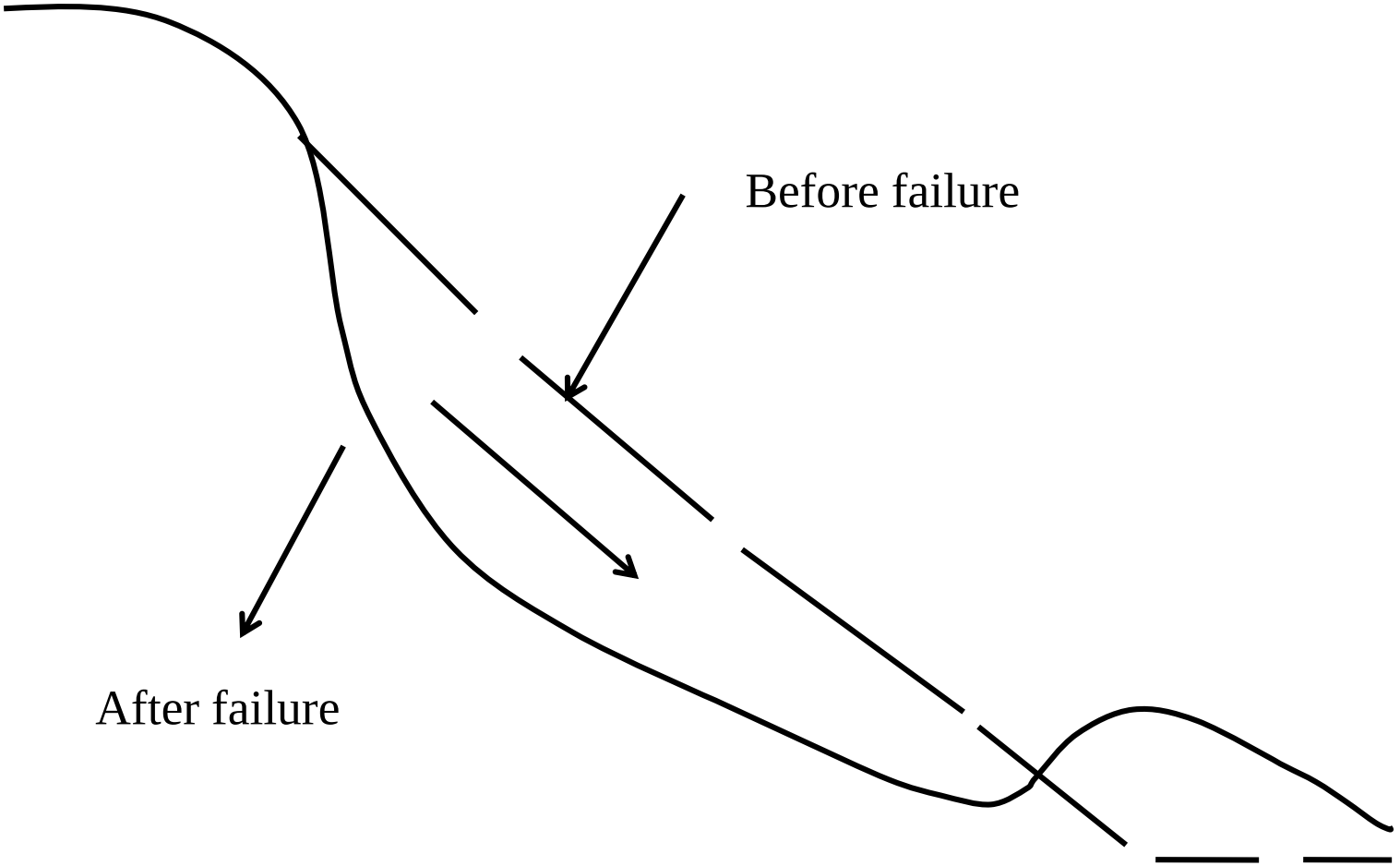
- Rain cut erosion –

  It depends on climate, soil types, and topography and vegetation growth on soil.

  Important climate parameter controlling rain cut erosion is intensity of rain and duration of rain fall.

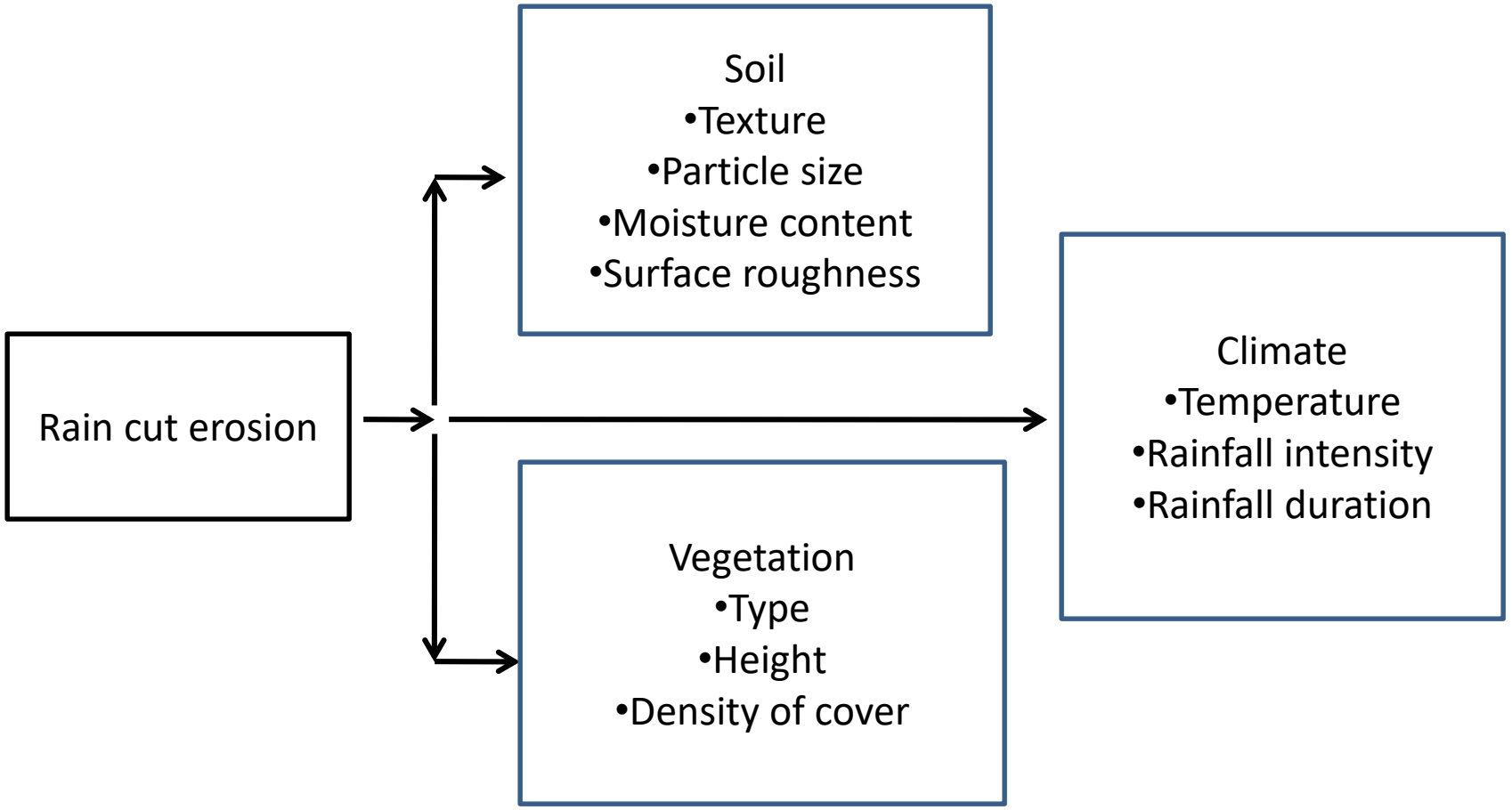


Surface run off on top soil

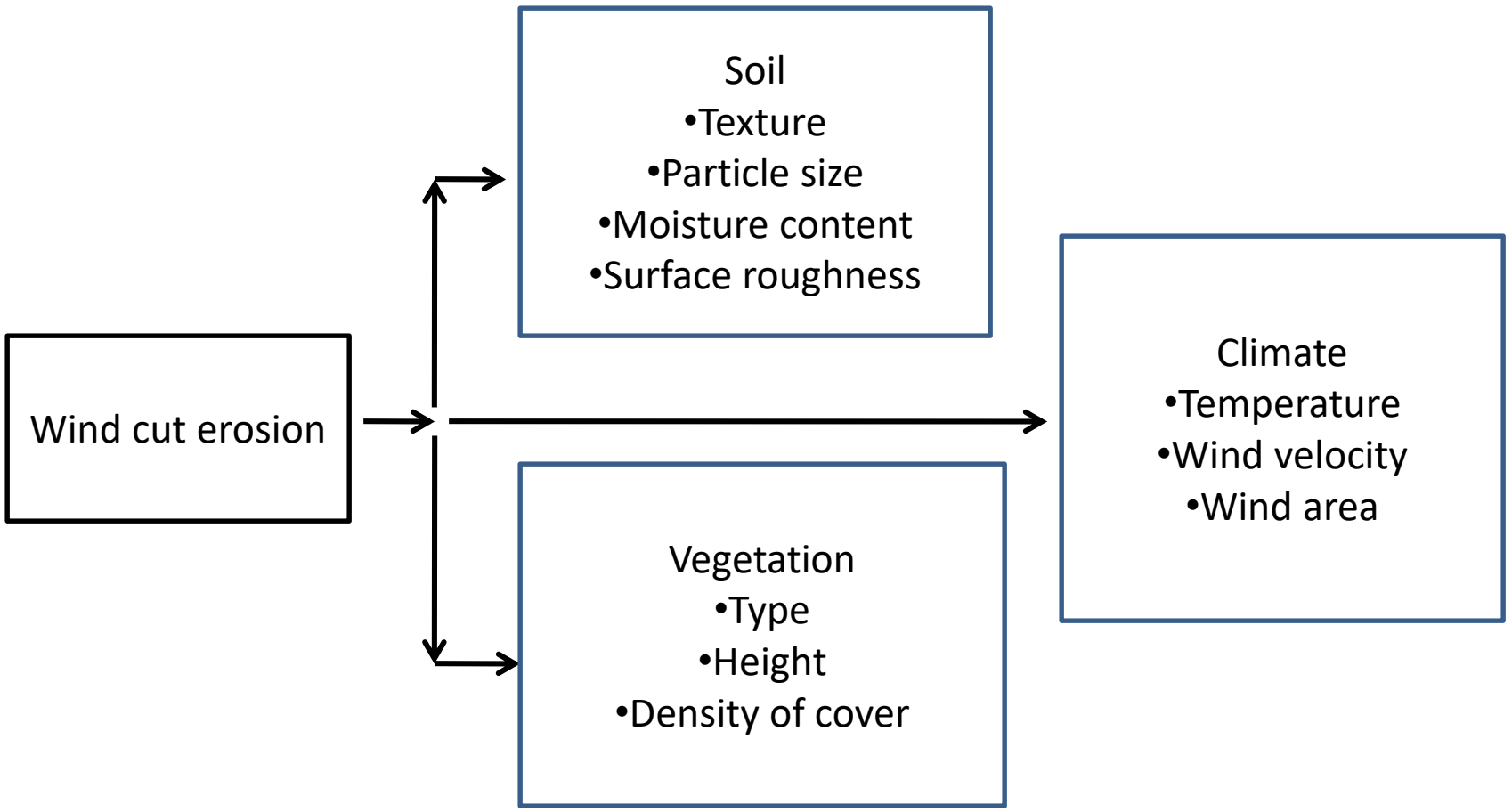


Mechanism of Rain cut erosion

Factors of rain cut erosion



Factor of wind erosion



Erosion Control Principle

- Erosion control of surface is prevented by many ways but from earlier time some technique and measure were introduced.
- They are effective in erosion control like as

(a) Growing plant on the side of roads.

(b) Install hydraulic machine to control the runoff

(c) Trying to decrease the velocity of fluid

(d) Dissipating the run off energy into other direction

(e) Fast growing herbs are planted

Susceptible soil for Erosion

- Some soil is more erodible than others. It's depends on soil granules and interlocking between the particles of soil. If the organic percentage in the soil increases and the clay size increases then decreases erodibility

- Many test are conducted on soil (volk 1973), crumb test (Emerson 1967) and pinhole test (Sherardet.al 1976). Some soil classification of soil depends on erodibility according to Unified soil Classification as

Movement of soil	**Size of particles (mm)**	**Percent of soil**
Suspension	<0.1	3-38
Skipping and bouncing	0.1-0.5	55-72
Surface creep(rolling and sliding)	0.5-1.0	7-25

Most Erodible soil	ML-Low plasticity silt
	SM=silty sand
	SC=Clayey sand
	MH=high plasticity silt
	CL= Low plasticity clay
	GM= silty gravel
	SW=well graded sand
	GP=Poorly graded gravel
Least erodible	GW=well graded gravel

Use of Vetiver Grass for Slope Stabilization

- Many researchers had studies about vetiver grass for slope stabilization Hengchaovanich et al. (1996) had studies the strength properties of vetiver grass of root in relation to slope stabilization. They observed that the tensile root strength of vetiver grass is much more than the other hardwood. It's root about (2.0m to 3.5m) long and better than many types of trees

- And the massive root network is very fast growing and fulfils the requirement of slope stabilization

- This is on account of vetiver grass roots have a high elasticity, normal 75 Mpa that can build shear quality of soil by a factor of 40 and when planted on inclines vetiver will lessen slant water powered weights through the expulsion of water.

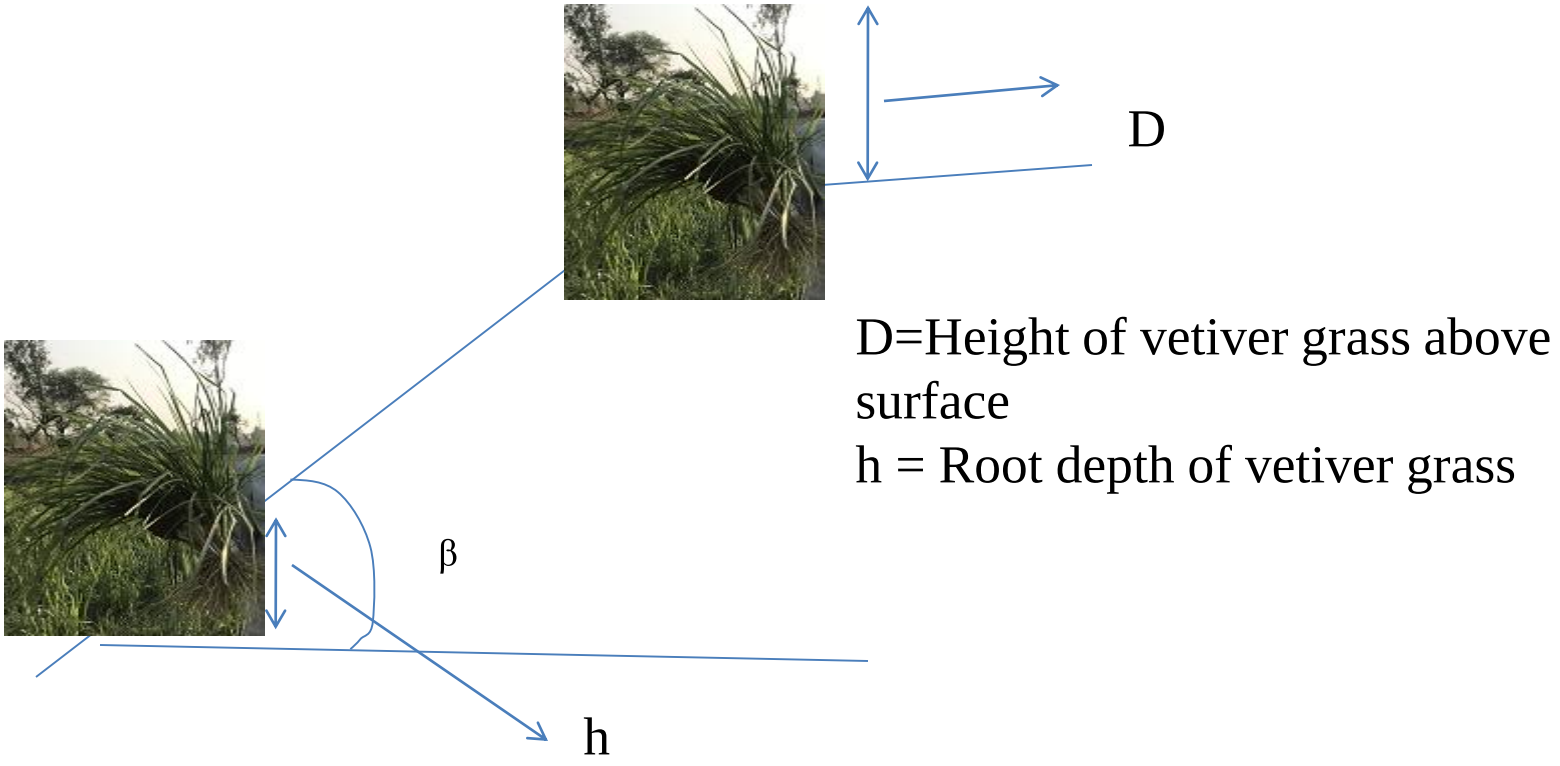
- They likewise decided the security factor of slants by utilizing the vetiver grass in the premise of in-situ shear quality of vetiver established soil grid and found that for a specific soil the factor of wellbeing of vetiver established soil slant is 1.8 to 2.1 times higher than the uncovered soil and contrasted the cost of vetiver and other conventional strategies.

Root strength of vetiver grass –

- Tensile strength depends upon diameter and type of testing. Tensile strengths of vetiver grass 70 MPa but appear to lie in the range of 10 to 40 MPa for many trees and shrubs. Tensile root fluctuates from around 8 to 80 MPa for root distances across going from 2 to 50 mm.
- $1/6^{th}$ tensile strength of mild steel.

Analysis of Vetiver Root in Slope Stability

- The stability of soil increases due to root penetration into the ground of vetiver grass. As growth of vetiver grass its root penetrates into ground only in one direction towards the earth crust.



D=Height of vetiver grass above surface
h = Root depth of vetiver grass

Erosion Control by Vetiver Grass

- In India on editing land with 1.7% slant, Vetiver form fences lessened spillover (as level of precipitation) from 23.3% (control) to 15.5%, soil misfortune from 14.4 t/ha to 3.9 t/ha and sorghum yield expanded from 2.52 t/ha to 2.88 t/ha over a four year time span. Overflow from the Vetiver plots was just 44% of that of the control plots on 2.8% incline and 16% on 0.6% slant.
- . In respect to control plots, normal diminishments of 69% in overflow and 76% in soil misfortune were recorded from Vetiver plots (Rao et al. 1992).

Slope Protection by Vetiver Grass

- Vetiver grass' morphological, physiological and environmental qualities including its resilience to exceedingly antagonistic developing conditions give an exceptional bio-designing apparatus for arrive adjustment, soil disintegration and residue control. The primary explanations behind incline shakiness are surface disintegration and basic shortcoming of the incline. While surface disintegration frequently prompts rill and chasm disintegration, basic shortcoming will cause mass development or landslip. Land aggravation by development exercises has brought about soil disintegration increments from two to 40 000 times the preconstruction rates with residue being the important transport component for a scope of toxins entering water.
- As said in the presentation, as vetiver turns out to be all the more generally embraced all inclusive, the execution should be enhanced as per rehearse on the ground. Sanguankaew et al. (2003) portray the experience of the Thai Department of Highways in executing the vetiver slant assurance chips away at rocky interstates in the North, Northeast and South Thailand.

Slope Stabilization and root strength of Vetiver grass

- Before we dig into the quality of vetiver attaches and their commitment to slant solidness, it is fundamental to characterize the 2 sorts of slips or mass developments that portray security issues. Slips or slides on inclines fall into 2 classes: profound situated and shallow situated. Profound situated issue is geotechnical or geographical in nature. It must be tended to considering slant geometry, soil quality, climatic condition, groundwater attributes, and so forth and can be found out by incline dependability investigation. For shallow-situated slip or shallow mass development (Gray and Leiser, 1982), the issue is to some degree hard to measure. Shallow slips of 1-1.5 m, then again, include the lion's share of issues looked by a great many people after incline arrangement, particularly in locales with drawn out and high precipitation. An elective arrangement, as specified in the Introduction, is to depend on vegetation, for this situation.vetiver, to help reinforce the surficial 1-1.5 m layer that is inclined to slippage. How vetiver establishes help in the reinforcing the external zone is clarified diagrammatically underneath (Fig. 1)
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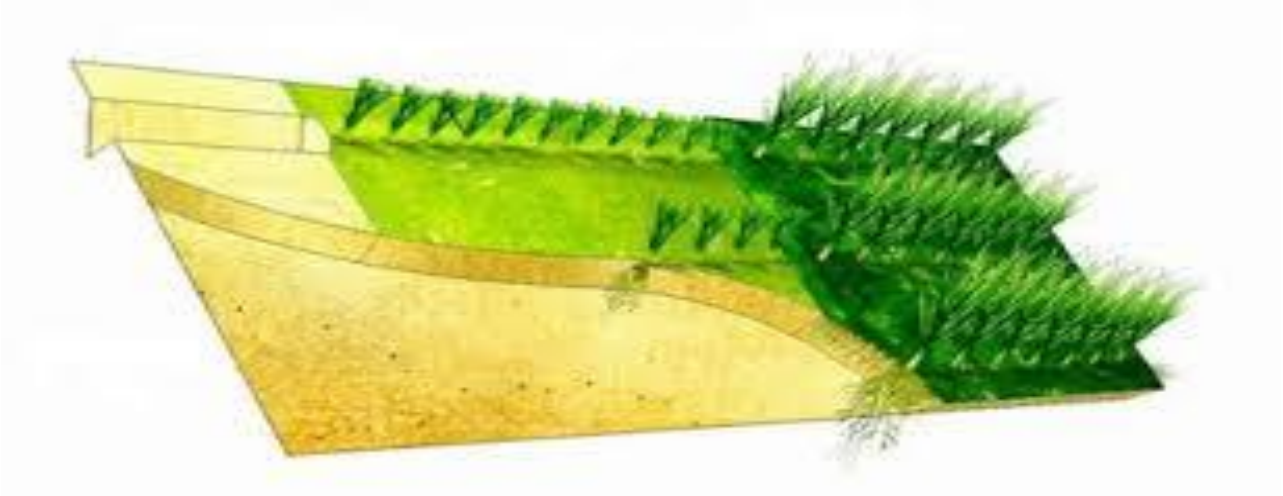

Slope protection by vetiver grass

Tensile root strength of Vetiver Grass

- Elasticity and shear quality of vetiver roots. Research directed by Hengchaovanich and Nilaweera (1996) demonstrated that the elasticity of vetiver roots increments with the lessening in root breadth. The elasticity of vetiver roots shifts between 40-180 Mpa for the scope of root breadth between 0.2-2.2 mm. The mean outline elasticity is around 75 Mpa (proportionate to roughly one 6th of mellow steel) at 0.7-0.8 mm root measurement, which is the most widely recognized size for vetiver roots.

COMPARISON OF SOIL PROPETIES BEFORE AND AFTER APLLICATION OF VETIVER

PROPERTIES	BEFORE VETIVER	AFTER 6 MONTHS	AFTER 12 MONTHS	AFTER 18 MONTHS
LIQUID LIMIT	20%	22%	25%	26%
PLASTIC LIMIT	9%	10%	10%	13%
PLASTICITY INDEX	11%	12%	14%	13%
OPTIMUM MOISTURE CONTENT	22.991 %	22.991 %	22.991 %	22.991 %
MAXIMUM DRY DENSITY	1.509 g/cc	1.61 g/cc	1.61 g/cc	1.628 g/cc
SPECIFIC GRAVITY	2.39	2.39	2.39	2.39
NATURAL MOISTURE CONTENT	4.451%	4.492%	4.128%	4.321%
SHEAR STRENGTH	0.37749kg/cm^3	0.3835kg/cm^3	0.5772kg/cm^3	0.7587kg/cm^3
SHEAR STRESS	0.3793kg/cm^2	0.3667kg/cm^2	0.4507kg/cm^2	0.5267kg/cm^2

CONCLUSIONS

- This study deals with the application of vetiver grass for slope stabilization purposes and its effect on soil properties. India is waste country with various topographical region. The use of vetiver grass for slope stabilization in India is very less. Many advantages with application of vetiver grass for slope stabilization like as environmental effect, low cost application, water conservation
- Various test were conducted on soil regarding its engineering properties to check the effect of application of vetiver grass after 6 months, 12 months and 18 months.
- Atterberg limit's were tested and Liquid Limit increases as vetiver grass growth with root penetration liquid limit increases due to root of vetiver grass penetrate and absorb water in the surrounding soil.

•Like as liquid limit increases plasticity also increases due to root penetration.

•The MDD of soil was found to increases after application of vetiver grass and it also showed subsequent increases along with root penetration.

•Also since the MDD increases it resulted in subsequent decrease in OMC.

•No significant increase or decreases in Natural moisture content was observed.

•Specific gravity remain same before and after application of vetiver.

•In general engineering properties of soil were improved with application of vetiver which will result in increase in strength and durability of soil and hence can be used on large scale.

•Vetiver grass root can be used for erosion control properties as the result indicated engineering properties of soil were also improved, so this can be used as a natural stabilizer

REFERENCES

- Adams, R. P., Dafforn, M. R. (1997). DNA fingerprints (RAPDs) of the pantropical grass, Vetiveria zizanioides L, reveal a single clone, “Sunshine,” is widely utilised for erosion control. Special Paper, The Vetiver Network, Leesburg Va, USA.
- Arifuzzaman (2011). “Effectiveness of Vetiver Grass in Slope Protection in a Coastal Area of Bangladesh”, M.Sc. Engg. Thesis, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Bangladesh.
- Chassie, R. G. and Goughnor, R. D. (1976). “National Highway Landslide Experience”, Highway Focus 8 (1), pp 1-9.
- Chepil, W. S. (1945). “Dynamics of Wind Erosion: Nature of Movement of Soil by Wind”, Soil Science, pp 305-320.
- Coppin, N. J. and Richards, I. G. (1990). “Use of vegetation in civil engineering”, Construction Industry Research and Information Association, Butterworths, London.

- Hengchaovanich, D. and Nilaweera, N. (1996). “An Assessment of Strength Properties of Vetiver Grass Roots in Relation to Slope Stabilization”, Proceedings of the First International Conference on Vetiver. Office of the Royal Development Projects Board, Bangkok, pp 153-158.

- Islam, M. S., Arifuzzaman and Nasrin, S. (2010). “In-situ Shear Strength of Vetiver Grass Rooted Soil”, Proceedings of Bangladesh Geotechnical Conference 2010: Natural Hazards and Countermeasure in Geotechnical Engineering, Dhaka, Bangladesh, pp 274-279.
- PIANC (1987). “Guidelines for the Design and Construction of Flexible Revetments Incorporating Geotextiles for Inland Waterways”, Supplement to Bulletin 57, Brussels, Belgium