Research Paper Engineering

Soil erosion & Advance Techniques of Soil Conservation

* Manish Gujarati ** Prof. H. M. Gandhi

* Student of M.E., Bhavnagar

** Prof & Head, Dept of Civil Engineering, Shantilal Shah Engineering College, Bhavnagar

ABSTRACT

The land is subjected to soil erosion and land degradation problem due to rain or wind action and faulty cultivation practices resulting in loss of topsoil, which is the place where all nutrients are available. Depending upon the rainfall, its intensities, and frequencies, an area becomes drought prone or flood affected. Soil erosion leads to poor yields, uneconomic returns, reservoir sedimentation, and reduction in storage capacity, reduction in area, and shutdown of hydro power stations, ecological imbalance, environmental pollution, droughts and floods. The study on soil conservation can play significant role in saving of land, improve it's soil structure, properties and water quality, good habitat for wildlife. it's also help in find out the factor affecting the soil erosion and establish relationship between them to find best fitted method to prevent or minimize soil erosion. In this paper gives the description of soil erosion, types of soil erosion and various Mechanical and vegetative techniques of conservation of soil, such as contour farming, Strip cropping, Terracing, Windbreaks, Grassed Waterways, riparian buffers, farm ponds, grade control structure, Pasture, Cover crops, Construction of Gabion Baskets etc.

Keywords : soil erosion, soil conservation, wind erosion, water erosion

I. INTRODUCTION

Erosion is the major cause for degradation for land resources. The process involves the detachment and transportation of soil. Up to some extent, the soil erosion is advantageous as well as of utmost importance as it is a natural physical phenomenon which has helped in shaping the present form of earth's surface. With the advent of modern civilization, the pressure on land increased, which has led to its overexploitation, and subsequently, its degradation. This triggered a very fast pace of erosion of soil from land surface due to the action of two fluids, wind and water. One recent estimate puts the loss of topsoil by water action at 12, 0000 M tones every year. It is worth to note that it takes nature 200-400 years to build up 1 cm of topsoil. In addition, 25 Mha of land has been degraded due to ravines and gullies, shifting cultivation, salinity / alkalinity, and water logging 30 to 50 M tones of food grains every year on account of loss of fertile topsoil from around 85 M ha of degraded agricultural lands. In this paper carry out the introduction and various types of soil erosion and various techniques of soil conservation.[1]

II. types of soil erosion

It is clear now that the process of soil erosion is continuous, either slow or sometimes speedy phenomenon, containing spatial and temporal variations which are having eroding elements and factors, contributing to the process of soil erosion and land degradation. Mainly, the types of soil erosion depending on the major eroding elements can be classified as wind erosion, water erosion and gravity erosion.

A. Wind erosion:

Wind erosion is the detachment and transport of soil particles by the forces of moving wind. In regions where the precipitation is low and the atmospheric temperature during the day high, the velocity of wind is invariably very high. Such climatic conditions are generally prevalent in arid and semiarid regions, where the wind velocity is also very high. Wind erosion is caused by mismanagement of land resources, such as intensive farming, over grazing, deforestation, etc. These practices destroy the cohesive properties and make them susceptible to wind erosion. Such erosion slowly leads to creation of sandy tracts, which in turn become more susceptible to wind erosion. The phenomenon of wind erosion passes through the following three stages:

1. Destruction of surface of the soil by the forces of wind
2. Transportation of the eroded soil to other destinations, and
3. Deposition of sediment particles when the wind velocity reduces

While, the movement of soil particles undergoes three steps, namely, surface creep, saltation and suspension.

B. Water erosion:

Erosion of soil by water is caused by its two forms – liquid as the flowing water, and solid as the glaciers. The impact of rainfall causes splash erosion. Runoff water causes scraping and transport of soil particles leading to sheet, rill and gully erosion. Water waves cause erosion of bank sides of reservoirs, lakes and oceans. The subsurface runoff causes soil erosion in the form of pipe erosion, which is also called tunnel erosion. The glacial erosion causes heavy landslides. In India, glacial erosions are mainly confined to Himalayan regions.

C. Gravitational erosion:

Gravitational erosion is caused by gravity in contrast to the physical movement of wind and water required for other types of soil erosion. Gravitational erosion involves both large scale mass wasting smaller scale erosion forms of gravitational erosion include avalanche, landslide, debris flow, mudflow and landslide. In this erosion, soil mass movement have been observed at various places in the world and classified in two types, namely, slump and creep.[1]

III. GLOBAL EXTENT OF SOIL DEGRADATION BY EROSION

The land area affected by soil degradation due to erosion is estimated at 1100 Mha by water erosion and 550 Mha by

wind erosion (Table). South Asia is one of the regions in the world where soil erosion by water and wind is a severe problem.[3]

TABLE I GLOBAL EXTENT OF SOIL DEGRADATION

World Regions	Total Land Area (10 ha)	Human induced soil degradation (10 ha)	Soil erosion (10 ha)	
			water	wind
Africa	2966	494	227	186
Asia	4256	748	441	222
South America	1768	243	123	42
Central America	306	63	46	5
North America	1885	95	60	35
Europe	950	219	114	42
Oceania	852	103	83	16
World total	13013	1965	1094	548

IV. SOIL CONSERVATION

Soil conservation is technique to identify factors affecting soil erosion and establish a relationship between them to find best fitted method to prevent erosion.

❖ **Why is required soil conservation?**

- When top soil is lost,fertility is reduced or destroyed, fertilizers must be used to restore fertility.
- When the Damaging to plants.
- When the Formation of rills and gullies affects management.
- When the Sedimentation in waterways.
- When the Delivery of nutrients to surface water.

V. SOIL CONSERVATION TECHNIQUES

Mechanical and vegetative practices are employed on milder slopes for conservation of soil, by farming across the slope of the land. The basic principle underlying this approach is to cause reduction in the effect of slope on the runoff velocity and thereby, reduce soil erosion. On steeper slopes, mechanical measures and structures are constructed to reduce the effect of slope on runoff velocity. The most common mechanical measure is the grading (leveling) of land surface, but on very steep slopes deeper cuts and fills are encountered which tend to expose the subsoil, and subsequently cause reductions in the fertility level of soil. In such cases, the land is divided into strips and laid across the slope in the forms of terraces and bunds.

The following vegetative and mechanical practices are being used at present:

A. Contour farming
B. Strip cropping
C. Terracing
D. Windbreaks
E. Grassed Waterways
F. Riparian buffers
G. Diverting acres
H. Farm ponds
I. Grade control structure
J. Pasture
K. Cover crops
L. Construction of Gabion Baskets

A. Contour farming:

Contouring is the practice of cultivation on contour lines, laid across the prevailing slope of the land where all farming operations, such as ploughing, sowing, planting, cultivation, etc. are carried out approximately on contours. The interculture operations create contour furrows, which along with plant stems act as very good barriers to the water flowing down the slope. These ridges also detain water for a longer period of time, which in turn, increases the opportunity time for the runoff water to infiltrate into the soil, and thereby increase the soil moisture. To lay a contour farming system contour guide lines are laid out first and tillage operations are carried out simultaneously. In soils with low infiltration rates, a non-erosive grade of 0.1 to 0.2% is provided to the contour guide line leading towards the outlet. The magnitude of control of soil erosion by this method varies with the land slope, crop cover and soil texture. It has been found that soils on lands with medium slopes and with good infiltration capacity best.[1]

B. Strip cropping:

Strip cropping is the practice of growing strips of crops having poor potential for erosion control. Such as root crops (which are intertilled crops), cereals, etc., alternated with strips of crops having good potential for erosion control, such as fodder crops, grasses, etc. Which are close growing crops. Strip cropping is a more intensive farming practice than farming only on contours. The farming practices that are included in this type of farming are contour strip farming, cover cropping, farming with conservation tillage and suitable crop rotation. A crop rotation with a combination of intertilled and close growing crops, farmed on contours, provides food, fodder and soil moisture. Close growing crops act as barriers to flow and reduce the runoff velocity generated from the strips of intertilled crops, and eventually reduce soil erosion.[1]

C. Terracing:

A terrace is an earth-embankment, constructed across the slope, to control runoff and minimize soil erosion. A terrace acts as an intercept to land slope, and divides the sloping land surface into strips. In limited widths of strips, the length of run of runoff is reduced. It has been found that soil loss is proportional to the square root of the length of slope, i.e. by shortening the length of run, soil erosion is reduced. The soil eroded by the runoff scour and the raindrop splash flows down the slope ,and gets blocked up by terraces. The scour of soil surface because of runoff water is initiated by the runoff at a velocity above the critical value, attained during a flow on a long length of the sloping run. By shortening the length of run, the runoff velocity remains less than the critical value and thus soil erosion owing to scour is prevented.[1]

D. Windbreaks:

Sometimes called a shelterbelt, a windbreak is a barrier of trees and shrubs that help to slow down the speed of wind. Sometimes farmers plant lines of trees just on their own land. These may serve as windbreaks as well as field boundaries. In other cases, windbreaks are planted to protect the soils and crops on several farms.[9]

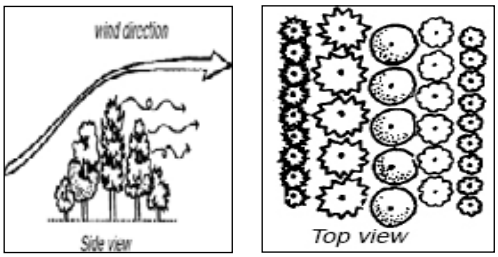

Fig.1 wind breakers
[source: *www.paceproject.net*]

A well-designed windbreak is the prevailing wind is slowed down at ground level, but wind is still able to pass through the trees. Stronger air currents stay high above the trees.[9]

A poorly-designed windbreak If wind is blocked completely, it will cause strong air currents over the land that should be protected. These can damage crops and promote erosion. If there are gaps in rows of trees, the wind is funnelled through them at higher speeds, resulting in more soil erosion.[9]

E. Grassed waterways:

Grassed waterways are also called vegetated drainage channels or, vegetated waterways. Such types of channels are

either naturally formed, or constructed as water courses and covered with grasses. These channels are used for the disposal of excess runoff from crop lands to some safe outlet, namely rivers, reservoirs, streams, etc. terraced and bunded crop lands, diversion channels, spillways, contour furrows, etc. from which excess runoff is to be disposed of, preferably use constructed vegetated waterways for safe disposal of their runoff. The vegetated outlets are constructed prior to the construction of terraces, bunds, etc. because grasses take time to establish on the channel bed. Generally, it is recommended that there should be a gap of one year so that the grasses can be established during the rainy season.

F. Riparian buffers:
Rich vegetation growing along the edges of a stream is commonly referred to as a the riparian zone. A valuable part of stream health, riparian buffer zones can be found in any type of landscape and are composed of water-loving plants and trees. Riparian buffer zones create a transition area between water and land that allows for habitat corridors as well as the natural, meandering curves in a river or stream, slowing the speed of water and stabilizing stream banks.

G. Diverting acres:
Diverting acres means taking land completely out of crop production, usually for many consecutive years. During that time, cover crops such as dense-rooted grasses and trees are planted. This land receives the benefits of reduced wind and water erosion, increased organic matter, improved soil structure, better moisture retention and improved water infiltration.

H. Farm ponds:
Farm ponds are formed by building a dam across an existing gully or low-lying area. Ponds help prevent soil erosion and protect water quality by collecting and storing run-off water. They also provide water for livestock, fish, wildlife and recreation.

I. Grade control structure:
Grade control structures are earthen, wooden or concrete structures built across a drainage way, like a grassed waterway, to prevent gully erosion by absorbing the water's energy, and reducing sediment carrying capability. Sometimes these structures are built to break up long waterways to slow water flow and prevent erosion and stream bank damage.

J. Pasture:
Pasture and hayland are often grown on soils that are too steep for row crop production. The heavy plant cover and tiny, dense root systems of grass or alfalfa slow water flow across the land and help keep soil in place, just the way native prairie grasses kept soil from eroding. Pastures and hayland protect water quality because the dense plants and roots filter runoff water. They also provide a good habitat for wildlife, and, as their plants recycle and roots die, organic matter enriches the soil.

K. *Cover crops:*
Cover crops are used to add organic matter to the soil while protecting topsoil from wind and water erosion. Small grains like rye, oats and winter wheat usually are used for cover crops. They keep the ground covered when other crops aren't growing on it, and help to trap nutrients. They also improve soil tilth, the chemical and physical condition that is beneficial to soil management, because their small roots help break up soil particles. Weed competition for future crops also is reduced when cover crops are in place.

L. Construction of Gabion Baskets:
Gabions (from Italian gabbione meaning "big cage"; from Italian gabbia and Latin cavea meaning "cage") are cages, cylinders, or boxes filled with soil or sand. Box gabions consist of rectangular units, fabricated from a double twist hexagonal mesh of soft annealed, heavy zinc coated wire. The double twist hexagonal mesh construction of the gabion permits it to tolerate differential settlement without fracture. A gabion basket is a heavy monolithic unit able to withstand earth thrust. It efficiency increases instead of deceasing with age since further consolidation takes place as silt and soil collect in the voids and vegetation establishes itself. There is little maintenance required for gabions. A minimum foundation preparation is required; the surface needs to be only reasonably plane Gabions are permeable. They can also be used in gully control and reclamation structures. For erosion control caged riprap is used. For dams or foundation construction, cylindrical metal structures are used.

VI. case study
A successful Project of this nature, aimed at stabilizing ravines based on the simple principle of promoting natural regeneration and vegetative measures as able mechanisms for preventing soil erosion , is a well-suited illustration for replication at a larger scale. Vast stretches of riverbanks still remain neglected across different parts of the state and country, and it is hoped that a larger project of such kind will be able to initiate activities in greater stretches along River Mahi,vadodara district,gujarat all the way from Vanakbori to Dhuvaran, spanning about 100 kms and covering 107 villages.

Fig.2 photograph for case study of soil conservation
[source:www.fes.org.in]

A view of revines along the bank of river mahi in Gujarat in 1986(left image) when soil and moisture conservation methods were being planned and a picture of the same in 2007(right image).[10]

VII. conclusion
From the present study we know about the land is subjected to soil erosion and land degradation problem due to rain or wind action and faulty cultivation practices resulting in loss of topsoil, which is the place where all nutrients are available. Depending upon the rainfall, its intensities, and frequencies, an area becomes drought prone or flood affected. Soil erosion leads to poor yields, uneconomic returns, reservoir sedimentation, and reduction in storage capacity, reduction in area, and shutdown of hydro power stations, ecological imbalance, environmental pollution, droughts and floods. The study on soil conservation can play significant role in saving of land, improve it's soil structure, properties and water quality, good habitat for wildlife. it's also help in find out the factor affecting the soil erosion and establish relationship between them to find best fitted method to prevent or minimize soil erosion. Mechanical and vegetative practices are employed on milder slopes for conservation of soil for preventing soil erosion

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