REAEARCH ON METHODS OF CONTROLLING SOIL EROSION

M. Ranjitham[1], R. Arun Prabhakaran[2], J. Dhanusuya[3]

[1]*Assistant Professor, Department of Civil Engineering, Bannari Amman institute of technology, Erode, Tamil Nadu, India*
[2,3]*Student, Department of Civil Engineering, Bannari Amman institute of technology, Erode, Tamil Nadu, India*

---***---

Abstract- *Soil erosion is a natural process in which particles of soil are moved by wind and water, and displaced to another location. When erosion occurs naturally, soil is relocated at about the same rate it is created, so no harm is done to the environment. Erosion is one of the biggest concerns of earth's land surface. It has many impacts on agricultural production and also in all engineering and construction industries. Erosion can be caused by multiple reasons, and every situation has a specific solution depending on the severity of the problem. The objective of this report is to highlight the various methods that can be employed to control soil erosion and the soil conservation practices that are needed for problem soils.*

Key Words: *soil erosion, land surface, conservation practices*

1. INTRODUCTION:

Soil erosion is a naturally occurring process that affects all landforms. The causes and effects should be studied in order to control soil erosion. Erosion, whether it is by water, wind or tillage, involves three distinct actions – soil detachment, movement and deposition. Erosion takes place all the time naturally. The erosion potential of any surface is determined by four basic factors: soil characteristics, vegetative cover, topography, and climate. Detachment, transport, and deposition are basic processes that occur on upland areas. Detachment of soil particles is a function of the erosive forces of raindrop impact and flowing water. Hydrology, topography, soil erodibility, soil transportability, soil surface cover, incorporated residue, residual land use, subsurface effects, tillage, roughness, and tillage marks are the major factors that affect upland erosion processes. Soil erosion control techniques are theoretically simple and easy but practically tough, time-consuming, laborious and costly. Almost all soil erosion techniques are very much site-specific.

2. EROSION AND SEDIMENTATION PROBLEMS:

Any changes made in the characteristics of the soil itself, are detrimental to infiltration, runoff patterns, and stream flow characteristics. For Example. if protective vegetation is reduced or eliminated, topsoil is removed and stockpiled, and cuts and fills are made, altering the topography and runoff characteristics of the site. This can increase the rate at which erosion takes place in a region.

Uncontrolled runoff and the resulting sediment pollution.

3. STUDIES NEEDED BEFORE ATTEMPTS:

The existing topographic features of the project site and the immediate surrounding area. The types, depth, slope, locations and limitations of the soils. The characteristics of the earth disturbance activity, including the past, present and proposed land uses and the proposed alteration to the project site. The volume and rate of runoff from the project site and its upstream watershed area. The location of all surface waters, which may receive runoff within or from the project site.

The preliminary works that are needed here are:

1. Carry out Supporting calculations and measurements.

2. Plan drawings. - Identification of the natural occurring geologic formations or soil conditions that may have the potential to cause pollution during earth disturbance activities.

3. Create Access roads.

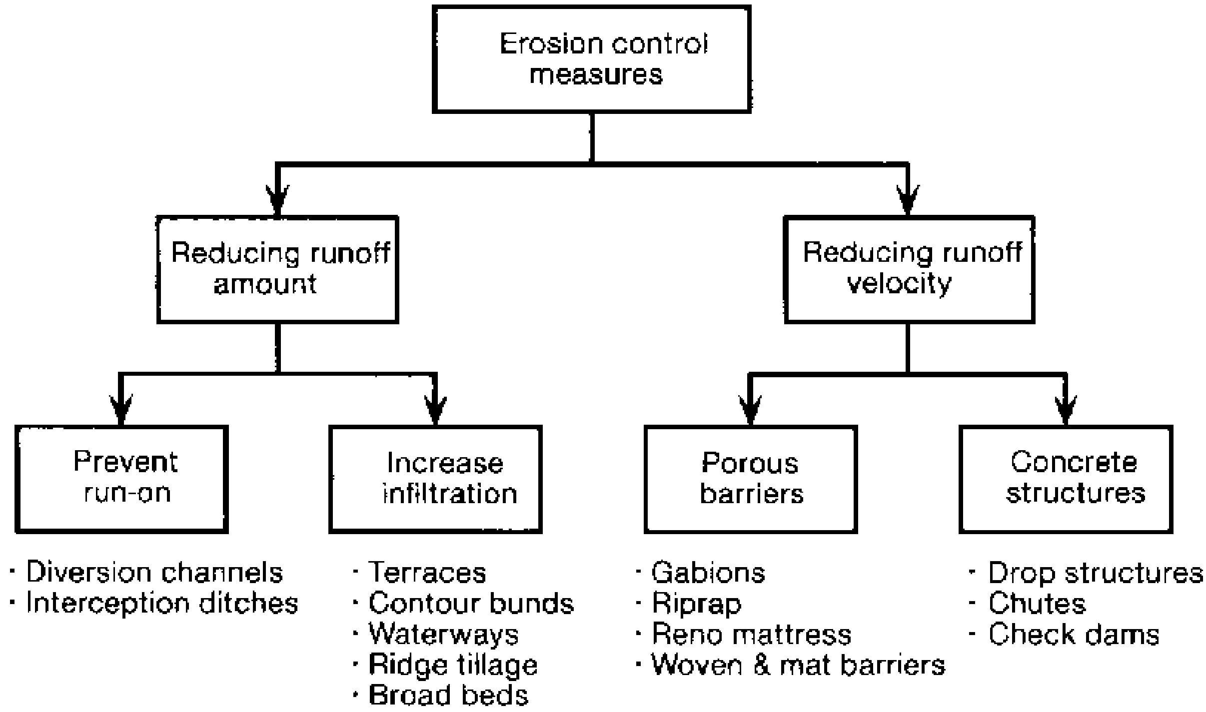
4. EROSION CONTROL METHODS:

This illustration shows the major methods employed in controlling soil erosion with reference to runoff factors.

There are two basic approaches as:

1. Reducing runoff amount and

2. Reducing runoff velocity.



2.1 FIVE MAIN TECHNIQUES

There are five main techniques that can be used in controlling soil erosion are. They are as follows:

(i) Contour bunding and Farming

(ii) Strip Cropping

(iii) Terracing

(iv) Gully Reclamation

(v) Shelter Belts.

Soil erosion can be controlled by adopting land management practices and also by changing the pattern of some human activities which accelerate soil erosion. One such idea is to minimize disturbance.

2.2 LAND DISTURBING ACTIVITIES:

The most effective form of erosion control is to minimize the area of disturbance. The land disturbing activities are the following:

a) QUARRIES:

Quarries are places of naturally occurring hard rock that is mined for rock and gravels.

The products from quarry operations are used for roading, building and in rock. protections measures, i.e., rip-rap. The following specific issues associated with quarry operations:

• Road access,

• Storm water

- Overburden disposal,
- Stockpile areas
- Rehabilitation of worked out areas
- Riparian protection areas
- Maintenance schedule for erosion and sediment control treatment structures.

b) TRENCHING:

Trenching (usually for installing utility services), often occurs at the end of bulk earthworks. Topsoil and sub-soils should be stockpiled separately adjacent to the trench so that at the completion of the operation these soils can be replaced in the appropriate order and vegetation established.

c) CLEAN FILLS:

Clean fills dispose of unwanted fill material which may contain other material.

d) ROADING:

The linear nature of roading poses challenges for erosion and sediment control measures. They need to be planned to ensure controls are successful.

2.3 MINIMISE DISTURBANCE:

The most effective form of erosion control is to minimize the area of disturbance, retaining as much existing vegetation as possible. This is especially important on steep slopes or in the vicinity of water bodies, where no single measure will adequately control erosion and where receiving environments may be highly sensitive. Match land development to land sensitivity. Watch out for and avoid areas that are wet (streams, wetlands, springs), have steep or fragile soils. Analyze all the "limits of disturbance".

a) STAGE CONSTRUCTION:

Temporary stockpiles, access and utility service installation all need to be considered.

b) PROTECT STEEP SLOPES:

Steep slopes should be avoided where practicable.

c) PROTECT WATER BODIES:

All water bodies and proposed drainage patterns.

Map all water bodies and show limits of disturbance and protection measures.

d) STABILISE EXPOSED AREAS RAPIDLY:

Conventional sowing to mulching. Mulching is an effective instant protection.

e) INSTALL PERIMETER CONTROLS:

Perimeter controls above the site keep clean water runoff out of the worked area. Common controls are diversion drains, silt fences and earth bunds.

f) EMPLOY DETENTION DEVICES:

Earthworks will still discharge sediment-laden runoff during storms.

g) RUNOFF DIVERSION CHANNEL/BUND :

This is a non-erodible channel or bund constructed for the conveyance of runoff constructed to a site specific cross section and grade design. It is done to either protect work areas from upslope runoff, or to divert sediment laden water to an appropriate sediment retention structure.

h) CONTOUR DRAIN:

It is a temporary ridge or excavated channel, or combination of ridge and channel, constructed to convey water across sloping land on a minimal gradient. To periodically break overland flow across disturbed areas in order to limit slope length and thus the erosive power of runoff and to divert sediment laden water to appropriate controls or stable outlets.

i) ROCK CHECK DAM:

Small temporary dam constructed across a channel (excluding perennial water bodies), usually in series, to reduce flow velocity. It may also retain coarse sediment. Check dams are constructed in order to reduce the velocity of concentrated flows, thereby reducing erosion of the channel. Rock check dams will trap some sediment, but they are not designed as a sediment retention measure.

j) LEVEL SPREADER:

A non-erosive outlet to disperse concentrated runoff uniformly across a slope. The level spreader provides a relatively low cost option, which can convert concentrated flow to sheet flow and release it uniformly over a stabilized area.

k) PIPE DROP STRUCTURE / FLUME:

A temporary pipe structure or constructed flume placed from the top of a slope to the bottom of a slope. A pipe drop structure or a flume structure is installed to convey surface runoff down the face of unsterilized slopes in order to minimize erosion on the slope face.

l) BENCHED SLOPE:

Modification of a slope by reverse sloping to divert runoff to an appropriate conveyance system. To limit the velocity and volume and hence the erosive power of water flowing down a slope and therefore minimizing erosion of the slope face.

m) SURFACE ROUGHENING;

Roughening a bare earth surface with horizontal grooves running across a slope or tracking with construction equipment. To aid in the establishment of vegetative cover from seed, to reduce runoff velocity, to increase infiltration, to reduce erosion and assist in sediment trapping.

n) STABILISED CONSTRUCTION ENTRANCE:

A stabilized pad of aggregate on a filter cloth base located at any point where traffic will be entering or leaving a construction site. To prevent site access points from becoming sediment sources and to assist in minimizing dust generation and disturbance of areas adjacent to the road frontage by giving a defined entry/exit point.

o) GEOSYNTHETIC EROSION CONTROL SYSTEMS (GECS):

The protection of channels and erodible slopes utilizing artificial erosion control material such as geosynthetic matting, geotextiles or erosion matting. To immediately reduce the erosion potential of

Disturbed areas and/or to reduce or eliminate erosion on critical sites during the period necessary to establish protective vegetation. There are both Temporary and Permanent Non-Degradable GECS.

2.4 REVEGETATION TECHNIQUES:

a) TOP SOILING:

The placement of topsoil over a prepared subsoil prior to the establishment of vegetation. To provide a suitable soil medium for vegetative growth while providing some limited short term erosion control capability.

b) TEMPORARY AND PERMANENT SEEDING:

The planting and establishment of quick growing and/or perennial vegetation to provide temporary and/or permanent stabilization on exposed areas. Temporary seeding is designed to stabilize the soil and to protect disturbed areas until permanent vegetation or other erosion control measures can be established.

c) HYDROSEEDING:

Hydro seeding is a planting process that uses slurry of seed and mulch. It is often used as an erosion control technique. The application of seed, fertilizer and a paper or wood pulp with water in the form of slurry which is sprayed over the area to be revegetated. To establish vegetation quickly while providing a degree of instant protection from rain drop impact.

d) MULCHING:

Mulches are loose coverings or sheets of material placed on the surface of cultivated soil. Organic mulches also improve the condition of the soil. As these mulches slowly decompose, they provide organic matter which helps keep the soil loose. This improves root growth, increases the infiltration of water, and also improves the water-holding capacity of the soil. The application of a protective layer of straw or other suitable material to the soil surface. To protect the soil surface from the erosive forces of raindrop impact and overland flow. Mulching assists in soil moisture conservation, reduces runoff and erosion, controls weeds, prevents soil crusting and promotes the establishment of desirable vegetation.

e) TURFING:

A surface layer of earth containing a dense growth of grass and its matted roots; sod. Turfing is an artificial substitute for such a grassy layer, as on a playing field. The establishment and permanent stabilization of disturbed areas by laying a continuous cover of grass turf. To provide immediate vegetative cover to stabilize soil on disturbed areas.

3.0 SEDIMENT CONTROL MEASURES

3.1 SEDIMENT RETENTION POND:

A temporary pond formed by excavation into natural ground or by construction of an embankment and incorporating a device to dewater the pond at a rate that will allow suspended sediment to settle out. To treat sediment-laden runoff and reduce the volume of sediment leaving a site, thus protecting downstream environments from excessive sedimentation and water quality degradation.

3.2 CHEMICAL FLOCCULATION SYSTEMS:

A treatment system designed to add a flocculating chemical to sediment retention ponds.

Used to increase the sediment capture performance of sediment retention ponds by causing suspended sediment to “clump” resulting in faster settling rates.

3.3 SILT FENCE:

The purpose of a silt fence is to retain the soil on disturbed land. The three principal aspects of silt fence design are: proper placement of fencing, adequate amount of fencing, and appropriate materials. A silt fence is a temporary sediment barrier made of porous fabric. It’s held up by

wooden or metal posts driven into the ground, so it’s inexpensive and relatively easy to remove. The fabric ponds sediment-laden storm water runoff, causing sediment to be retained by the settling processes. A temporary barrier of woven geotextile fabric is also used to intercept sediment laden runoff from small areas of soil disturbance.

3.4 SUPER SILT FENCE:

A temporary barrier of woven geotextile fabric over chain link fence used to intercept sediment laden runoff from soil disturbance in small catchment areas. A super silt fence provides more robust sediment control compared with a standard silt fence and allows up to four times the catchment area to betreated by an equivalent length of standard silt fence.

3.5 STORMWATER INLET PROTECTION:

A barrier across or around a cesspit (storm water inlet). To intercept and filter sediment-laden runoff before it enters a reticulated storm water system via a cesspit, thereby preventing sediment-laden flows from entering receiving environments

3. 6 DECANTING EARTH BUND:

A temporary berm or ridge of compacted earth constructed to create impoundment areas where ponding of runoff can occur and suspended material can settle before runoff is discharged. Used to intercept sediment-laden runoff and reduce the amount of sediment leaving the site by detaining sediment-laden runoff.

3.7 DECANTING TOPSOIL BUND:

A temporary berm or ridge of track rolled topsoil, constructed to create impoundment areas where ponding of runoff can occur and suspended material can settle before runoff is discharged. Used to intercept sediment-laden runoff from small areas (less than 0.3 ha) and reduce the amount of sediment leaving the site by detaining sediment-laden runoff.

3.8 SUMP / SEDIMENT PIT:

A temporary pit which is constructed to trap and filter water before it is pumped to a suitable discharge area. To treat sediment-laden water that has been removed from areas of excavation or areas where ponded sediment-laden water cannot drain by other means.

3.9 RIPRAP:

Rock pieces are piled up to create a structure called as rip-rap. These are rubble composed of a variety of rock types including limestone and granite, which are used to armor embankments, shorelines, bridge abutments, streambeds and other seaside constructions to prevent soil erosion due to concentrated runoff or other water-related causes. A limitation of riprap arises when the slopes of the considered area are greater than 2:1; the rubble becomes unstable and is itself prone to erosion. In these circumstances, gabions are used.

3.10 GABIONS:

Gabbion is an Italian word gabbia meaning “cage”. The gabions are riprap encased in galvanized, steel- wire mesh cages or cylinders. These are used to stabilize slopes, stream banks, or shorelines against erosion. They are usually placed on slopes at an angle—either battered or stepped back, rather than stacked vertically. The life expectancy of gabions rely entirely on their wire frames, and premium ones have a guaranteed structural consistency of fifty years.

3.11 BUFFER STRIP:

These are narrow areas of land maintained in permanent vegetation to trap sediment, slow down runoff, and even control air, soil, and water quality. The root systems of the vegetation anchor soil particles together which help stop the soil from being eroded by winds. They also reduce the risk of landslides and other slower forms of erosion by stabilizing stream banks.

3.12 SOIL BINDERS:

Soil binders bind soil particles together in order to make the soil matrix more water and pressure resistant. Soil binder has two functions: erosion control and soil stabilization. The success of common soil binder applications varies significantly depending on the local conditions and use of stabilized soil. Soil binders have multiple purposes: soil stabilization, dust control and erosion control. Some soil binder products can combat all these issues at the same time. Cement is commercial soil binder although it has numerous drawbacks. Lime soil binder products are quicklime, hydrated lime and lime slurry. Fly ash is typically used to stabilize sub base or sub grade, and is not among soil binder products suitable for surfacing due to low resistance to abrasive action of traffic. Fly ash application has adverse effect on environment.

4.0 WORKS IN WATER BODIES

Works within water bodies have a high potential for erosion and discharge of sediment. This is because work is undertaken in or near flowing water - the major cause of erosion. Flowing water causes ongoing scour and provides the transport mechanism to Allow sediment to be dispersed downstream of works.

a) TEMPORARY WATER BODY DIVERSIONS:

A short term water body diversion to allow works to occur within the main channel under dry conditions. To enable water body diversion without working in wet conditions and without allowing sediment discharges into a water body.

b) TEMPORARY WATER BODY CROSSINGS:

A bridge, culvert or ford installed across a water body for short-term use. To provide a means to cross water bodies without moving sediment into the water body, damaging the bed or channel, or causing flooding during the construction, maintenance or removal of the structure.

5.0 SOIL CONSERVATION METHODS:

The preeminent methods of soil conservation are:

- Expansion of vegetative cover and protective afforestation,
- Controlled grazing,
- Flood control,
- Prohibition of shifting cultivation,
- Proper land utilization,
- Maintenance of soil fertility,
- Land reforms, reclamation of wasteland,
- Establishment of soil research institute and training of soil scientists, and
- Effective agencies for soil management

6.0 CONCLUSION:

Erosion is the loss of soil. As soil erodes, it loses nutrients, clogs rivers with dirt, and eventually turns the area into a desert. Although erosion happens naturally, human activities can make it much worse. Erosion can turn once healthy, vibrant land into arid, lifeless terrain and further cause landslides and mudslides. Erosion can be controlled easily on a construction site when the right means, tools, and methods are used at the right time. The most natural and effective way to prevent erosion control is by planting vegetation. Roots from plants, especially trees, grip soil and will effectively prevent the excess movement of soil throughout the ground. Another popular erosion control method is the use of a silt fence. A silt fence is a long fabric barrier that is installed along a hill, and collects any storm water that would carry loose soil another effective technique used for soil erosioncontrol is erosion control matting. Erosion control matting is laid on top of loose soil and is secured into place.

7.0 REFERENCE:

1. Al-Hamdan, O. Z., F. B. Pierson, M. A. Nearing, C. J. Williams, J. J. Stone, P. R. Kormos, J. Boll, and M. A. Weltz. 2013. Risk assessment of erosion from concentrated flow on rangelands using overland flow distribution and shear stress partitioning. Trans. ASABE 56(2): 539-548.
2. Al-Madhhachi, A. T., G., J. Hanson, G. A. Fox, A. K. Tyagi, and R. Bulut. 2013. Deriving parameters of a fundamental detachment model for cohesive soils from flume and jet erosion tests. Trans. ASABE 56(2): 489-504.

3. Arnhold, S., M. Ruidisch, S. Bartsch, C. L. Shope, and B. Huwe. 2013. Simulation of runoff patterns and soil erosion on mountainous farmland with and without plastic-covered ridgefurrow cultivation in South Korea. Trans. ASABE 56(2): 667- 679.

4. Bonelli, S., O. Brivois, R. Borghi, and N. Benahmed. 2006. On the modelling of piping erosion. Comptes Rendus Mécanique 334(8-9): 555-559.

5. Chen, J., J. Vaughan, J. Avise, S. O'Neill, and B. Lamb. 2008. Enhancement and evaluation of the AIRPACT ozone and PM2.5 forecast system for the Pacific Northwest. J. Geophys. Res. 113(D14): doi: 10.1029/2007JD009554.

6. Klik, A., and F. Konecny. 2013. Rainfall erosivity in northeastern Austria. Trans. ASABE 56(2): 719-725.

7. Lenhart, C. F., M. Titov, J. A. Ulrich, J. L. Nieber, and B. Suppes. 2013. The role of hydrologic alteration and riparian vegetation dynamics in channel evolution along the lower Minnesota River. Trans. ASABE 56(2): 549-561.

8. McCool, D. K., S. Dun, J. Q. Wu, W. J. Elliot, and E. S. Brooks. 2013. Seasonal change of WEPP erodibility parameters for two fallow plots on a Palouse silt loam. Trans. ASABE 56(2): 711- 56(2): 455-463 463 718.

9. Von Werner, M. 2009. EROSION 3D Benutzerhandbuch. Reliefanalysemodell 2. Berlin, Germany: GeoGnostics 575 Software.

10. Wagner, L. E., and F. A. Fox. 2013: The management submodel of the Wind Erosion Prediction System. Applied Eng. in Agric. 29: (in press).