Chapter 5

BANK STABILIZATION

Description

Bank stabilization is the process of establishing and implementing resistive measures against erosion and failure of roadway cut slopes or fill embankments. Stabilization may be achieved by either mechanical (structural) means, vegetative, or both.

Erosion can be directly caused by direct rainfall, runoff, wind, freezing, gravity, or a combination of these. The magnitude of these parameters can be effected by changes in upland land use, fire, tree harvest, etc. Indirect causes include flow-line scour within a road ditch, diverted or impeded flow by obstacles within drainage ways and culverts, wave action, seepage, over-bank drainage, off-road vehicles, maintenance machinery, etc.

Bank or slope failure occurs when a section of the bank slides. There are many potential causes. One cause is too steep of a slope gradient for the strength of the soil. High shrink/swell soils (usually fine clays) tend to have the weakest slope stability. These soils crack during dry weather opening fissures which allow rainfall to enter, and thus saturate the soil causing high ranges of swelling. The swelling reduces the soil density, which never recovers when the soil dries out, thus causing further, more extensive cracking. Subsequent rainfall during this cycle will eventually deliver a load and lubrication which the weakened soil cannot resist, resulting in "slip-plane" failure. Other soils, including some sands and sand-clays, are just too weak to "stand" at the steep grades impose on them.

Other causes of slope failure have to do with improper soil compaction, slope toe erosion, groundwater pressure, and excessive artificial loads placed on the slope, such as building construction, automobile parking, etc.

Importance to Maintenance & Water Quality

Proper long term stabilization of banks along roadways and drainage ways will significantly reduce if not prevent costly maintenance, and will contribute significantly to the reduction and prevention of considerable amounts of sediment delivery into streams and waterways. Stable road banks also decrease public disenchantment, improves motorist safety, improves traffic flow, and protects adjacent land.

Implementation

Construction and Grading/Re-Grading

Bank construction and maintenance procedures in relation to compaction (for fills), slope gradient, and surface grading is critical to establishing a long term, stable slope.

Fill slopes should be compacted to a density commonly stable for the soil material used. Loose fill should be placed on a relatively level, scarified surface (roughened one inch) in lifts not to exceed 12 inches, and thoroughly compacted before more material is added. Compaction equipment must cover the entire surface, preferably in a cris-cross pattern, sufficient enough times to achieve the desired compaction. Tests may be required to determine the level of compaction (density). With familiar soils, established, common, and proven methods may be routinely used for expediency and economy. Most fill slopes should be 3 feet horizontal to 1 foot vertical (3:1) or flatter for stability, however, some soils can be placed at steeper slopes to accommodate limited space. Evaluation of the soil material should be made by a professional engineer to determine whether slopes flatter or steeper than 3:1 should be used.

Smooth, and even grading of the slope surface will enhance aesthetics and will also improve the ability to establish a good vegetative cover and maintain it. Slope grades should be straight and true without humps, bellies, dips or ridges. This will reduce concentration of runoff on slopes and promote sheet flow which is less erosive and enhances infiltration of water needed for plant growth. Vertical tracking (up & down slope) with a dozer will also enhance infiltration.

Bank-Grading Techniques

Terracing

The construction of benches on long and/or excessively steep slopes to provide breaks and near level "troughed" areas in the slope which will intercept runoff. These troughs are back-sloped from the slope face to catch runoff and channel it to either end of the embankment. (See figure 5-1).

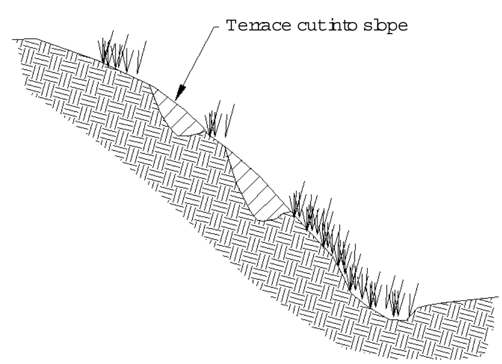

Figure 5-1. Slope Terracing

Cutting and/or Filling

The removal and/or addition of soil to the bank to create the desired slope. May result in flattening the slope to a stable gradient, or involve replacing less stable soils with more stable soil material in the process of regrading the slope. Maximum slope grade should be 3:1 for fill slopes, and 2:1 for cut slopes. (See figure 5-2).

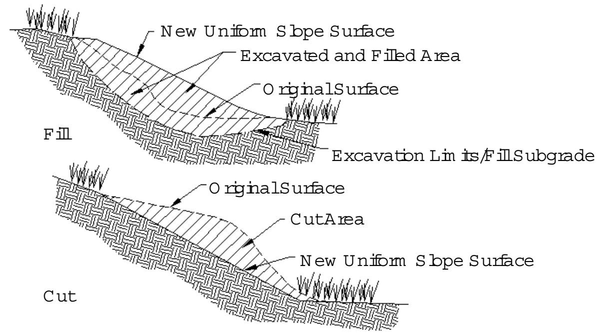

Figure 5-2. Slope Shaping by Cutting and/or Filling

Keying

The cutting of a trench or bench into a slope surface prior to placing fill on it in order to prevent slippage or creep of the added fill. This method is often used when replacing slide material back onto the slope from which it came. (See figure 5-3).

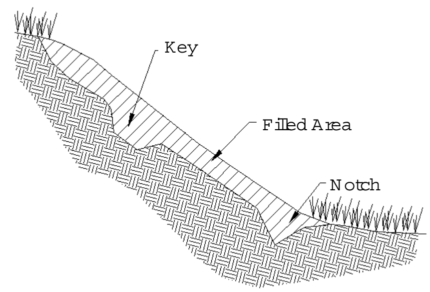

Figure 5-3. Slope Keying for Fill Placement

Counter-weighting

The placing of material (soil, rock, etc.) at the toe of a slope to prevent or halt sliding. The mass weight of the counter-weighting material must exceed the mass weight of the sliding material above it. (See figure 5-4).

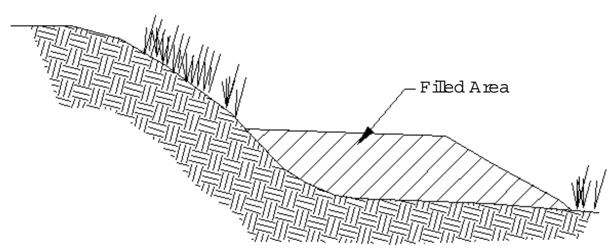

Figure 5-4. Counter-weighting Toe of Slope

Vegetation by Grass Seeding

Grass seeding is the most efficient and cost effective method of stabilizing banks and slopes. This method should always be considered first and use wherever possible. Grass will slow water movement and allow more infiltration. It will effectively hold soil particles in place, reducing sedimentation. The following should be followed when establishing vegetation by seeding.

a. Slopes to be seeded should be no steeper than 2 horizontal to 1 vertical (2:1) and should be covered with a minimum of 2 inches of topsoil. Finish grading should always follow top soil placement.

b. Where soils are unstable, use sod or erosion control blanket and place immediately. Consider mulching graded and finished areas before a rain event if seeding can not be performed.

c. Seed bare areas as soon as possible after disturbance, preferably as soon as a significant area is graded and finished and before the next rain event.

d. Fertilize and lime the area as needed based on soil condition and disk or rake it into the soil surface to a depth of 2 to 4 inches.

e. Use temporary seeding when outside the seeding dates for permanent vegetation.

f. Apply a seed mixture which is appropriate for the climate, soil, and drainage conditions of the site.

g. Seeding can be done by hand or machine broadcasting, or by hydro-seeding. **Do not mix seeds of different sizes** when broadcasting as this will yield an uneven disbursement of seeds. Hydro-seed areas where it is unlikely to get an even disbursement of seeds or a satisfactory germination.

h. Mulch the surface immediately at a rate of 1-1/2 tons per acre and anchor with a disk harrow, mulch anchoring tool, or by tracking. Tracking the mulch in with a dozer is acceptable where soil conditions and moisture are ample to avoid sticking, and the mulch can be adequately creased into the earth. Tracking must be done walking the dozer up and down the slope, making the track creases as near perpendicular to the slope grade as possible.

i. Seeding can sometimes be use in combination with other type vegetation such as trees, shrubs, willow spikes, etc. planted after seeding is complete.

Proper seedbed prep, and straw or mattress mulching, including crimping or pinning . . .

. . . along with other pre-establishment site protection will yield well vegetated, stable, and more easily maintainable . . .

roadway shoulders . . .

roadway ditches . . .

soil storage areas, . . . culvert inlets & outlets, . . . and sediment control.

Exhibit 5.1 - Vegetation by Grass Seeding