Permanent Seeding

Construction Site Storm Water Runoff Control

Description

Permanent seeding is used to control runoff and erosion on disturbed areas by establishing perennial vegetative cover from seed. It is used to reduce erosion, to decrease sediment yields from disturbed areas, and to provide permanent stabilization. This practice is economical, adaptable to different site conditions, and allows selection of the most appropriate plant materials.

Hydroseeding is a popular technique for applying seeds, fertilizer, and chemical stabilizers in a single application (Source: Terra Firma Industries, 2000)

Applicability

Permanent seeding is well-suited in areas where permanent, long-lived vegetative cover is the most practical or most effective method of stabilizing the soil. Permanent seeding can be used on roughly graded areas that will not be regraded for at least a year. Vegetation controls erosion by protecting bare soil surfaces from displacement by raindrop impacts and by reducing the velocity and quantity of overland flow. The advantages of seeding over other means of establishing plants include lower initial costs and labor inputs.

Siting and Design Considerations

Areas to be stabilized with permanent vegetation must be seeded or planted 1 to 4 months after the final grade is achieved unless temporary stabilization measures are in place. Successful plant establishment can be maximized with proper planning; consideration of soil characteristics; selection of plant materials that are suitable for the site; adequate seedbed preparation, liming, and fertilization; timely planting; and regular maintenance. Climate, soils, and topography are major factors that dictate the suitability of plants for a particular site. The soil on a disturbed site might require amendments to provide sufficient nutrients for seed germination and seedling growth. The surface soil must be loose enough for water infiltration and root penetration. Soil pH should be between 6.0 and 6.5 and can be increased with liming if soils are too acidic. Seeds can be protected with mulch to retain moisture, regulate soil temperatures, and prevent erosion during seedling establishment.

Depending on the amount of use permanently seeded areas receive, they can be considered high- or low-maintenance areas. High-maintenance areas are mowed frequently, limed and fertilized regularly, and either (1) receive intense use (e.g., athletic fields) or (2) require maintenance to an aesthetic standard (e.g., home lawns). Grasses used for high-maintenance areas are long-lived perennials that form a tight sod and are fine-leaved. High-maintenance vegetative cover is used for homes, industrial parks, schools, churches, and recreational areas.

Low-maintenance areas are mowed infrequently or not at all and do not receive lime or fertilizer on a regular basis. Plants must be able to persist with minimal maintenance over long periods of time.

Grass and legume mixtures are favored for these sites because legumes fix nitrogen from the atmosphere. Sites suitable for low-maintenance vegetation include steep slopes, stream or channel banks, some commercial properties, and "utility" turf areas such as road banks.

Limitations

The effectiveness of permanent seeding can be limited because of the high erosion potential during establishment, the need to reseed areas that fail to establish, limited seeding times depending on the season, and the need for stable soil temperature and soil moisture content during germination and early growth. Permanent seeding does not immediately stabilize soils—temporary erosion and sediment control measures should be in place to prevent off-site transport of pollutants from disturbed areas.

Maintenance Considerations

Grasses should emerge within 4–28 days and legumes 5–28 days after seeding, with legumes following grasses. A successful stand should exhibit the following:

- Vigorous dark green or bluish green seedlings, not yellow
- Uniform density, with nurse plants, legumes, and grasses well intermixed
- Green leaves—perennials should remain green throughout the summer, at least at the plant bases.

Seeded areas should be inspected for failure, and necessary repairs and reseeding should be made as soon as possible. If a stand has inadequate cover, the choice of plant materials and quantities of lime and fertilizer should be reevaluated. Depending on the condition of the stand, areas can be repaired by overseeding or reseeding after complete seedbed preparation. If timing is bad, rye grain or German millet can be overseeded to thicken the stand until a suitable time for seeding perennials. Consider seeding temporary, annual species if the season is not appropriate for permanent seeding. If vegetation fails to grow, soil should be tested to determine if low pH or nutrient imbalances are responsible.

On a typical disturbed site, full plant establishment usually requires refertilization in the second growing season. Soil tests can be used to determine if more fertilizer needs to be added. Do not fertilize cool season grasses in late May through July. Grass that looks yellow may be nitrogen deficient. Do not use nitrogen fertilizer if the stand contains more than 20 percent legumes.

Effectiveness

Perennial vegetative cover from seeding has been shown to remove between 50 and 100 percent of total suspended solids from storm water runoff, with an average removal of 90 percent (USEPA, 1993).

Cost Considerations

Seeding costs range from $200 to $1,000 per acre and average $400 per acre. Maintenance costs range from 15 to 25 percent of initial costs and average 20 percent (USEPA, 1993).

References

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Sodding

Construction Site Storm Water Runoff Control

Description


Grass sod is laid on exposed soil to stabilize the soil and to reduce the velocity of storm water runoff (Source: Landscape USA, no date)

Sodding is a permanent erosion control practice that involves laying a continuous cover of grass sod on exposed soils. In addition to stabilizing soils, sodding can reduce the velocity of storm water runoff. Sodding can provide immediate vegetative cover for critical areas and stabilize areas that cannot be vegetated by seed. It also can stabilize channels or swales that convey concentrated flows and can reduce flow velocities.

Applicability

Sodding is appropriate for any graded or cleared area that might erode, requiring immediate vegetative cover. Locations particularly well-suited to sod stabilization are:

- Residential or commercial lawns and golf courses where prompt use and aesthetics are important
- Steeply-sloped areas
- Waterways and channels carrying intermittent flow
- Areas around drop inlets that require stabilization.

Siting and Design Considerations

Sodding eliminates the need for seeding and mulching and produces more reliable results with less maintenance. Sod can be laid during times of the year when seeded grasses are likely to fail. The sod must be watered frequently within the first few weeks of installation.

The type of sod selected should be composed of plants adapted to site conditions. Sod composition should reflect environmental conditions as well as the function of the area where the sod will be laid. The sod should be of known genetic origin and be free of noxious weeds, diseases, and insects. The sod should be machine cut at a uniform soil thickness of 15 to 25 mm at the time of establishment (this does not include top growth or thatch). Soil preparation and additions of lime and fertilizer may be needed; soils should be tested to determine if amendments are needed. Sod should be laid in strips perpendicular to the direction of waterflow and staggered in a brick-like pattern. The corners and middle of each strip should be stapled firmly. Jute or plastic netting may be pegged over the sod for further protection against washout during establishment. Areas to be sodded should be cleared of trash, debris, roots, branches, stones and clods larger than 2 inches in diameter. Sod should be harvested, delivered, and installed within a period of 36 hours. Sod not transplanted within this period should be inspected and approved prior to its installation.

Limitations

Compared to seed, sod is more expensive and more difficult to obtain, transport, and store. Care must be taken to prepare the soil and provide adequate moisture before, during, and after installation to ensure successful establishment. If sod is laid on poorly prepared soil or unsuitable surface, the grass will die quickly because it is unable to root. Sod that is not adequately irrigated after installation may cause root dieback because grass does not root rapidly and is subject to drying out.

Maintenance Considerations

Watering is very important to maintain adequate moisture in the root zone and to prevent dormancy, especially within the first few weeks of installation, until it is fully rooted. Mowing should not result in the removal of more than one-third of the shoot. Grass height should be maintained between 2 and 3 inches. After the first growing season, sod might require additional fertilization or liming. Permanent, fine turf areas require yearly maintenance fertilization. Warm-season grass should be fertilized in late spring to early summer, and cool-season grass, in late winter and again in early fall.

Effectiveness

Sod has been shown to remove up to 99 percent of total suspended solids in runoff. It is therefore a highly effective management practice for erosion and sediment control, but its trapping efficiency is highly variable depending on hydrologic, hydraulic, vegetation, and sediment characteristics.

Cost Considerations

Average construction costs of sod average $0.20 per square foot and range from $0.10 to $1.10 per square foot; maintenance costs are approximately 5 percent of installation costs (USEPA, 1993).

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Soil Roughening

Construction Site Storm Water Runoff Control

Description

Soil roughening is a temporary erosion control practice often used in conjunction with grading. Soil roughening involves increasing the relief of a bare soil surface with horizontal grooves, stair-stepping (running parallel to the contour of the land), or tracking using construction equipment. Slopes that are not fine graded and that are left in a roughened condition can also reduce erosion. Soil roughening reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares the soil for seeding and planting by giving seed an opportunity to take hold and grow.

Exposed soils can be temporarily stabilized by driving a tractor over the surface

Applicability

Soil roughening is appropriate for all slopes. Soil roughening works well on slopes greater than 3:1, on piles of excavated soil, and in areas with highly erodible soils. This technique is especially appropriate for soils that are frequently mowed or disturbed because roughening is relatively easy to accomplish. To slow erosion, roughening should be done as soon as possible after the vegetation has been removed form the slope. Roughening can be used with both seeding and planting and temporary mulching to stabilize an area. For steeper slopes and slopes that will be left roughened for longer periods of time, a combination of surface roughening and vegetation is appropriate. Roughening should be performed immediately after grading activities have ceased (temporarily or permanently) in an area.

Siting and Design Considerations

Rough slope surfaces are preferred because they aid the establishment of vegetation, improve infiltration, and decrease runoff velocity. Graded areas with smooth, hard surfaces might seem appropriate, but such surfaces may increase erosion potential. A rough soil surface allows surface ponding that protects lime, fertilizer, and seed. Grooves in the soil are cooler and provide more favorable moisture conditions than hard, smooth surfaces. These conditions promote seed germination and vegetative growth.

It is important to avoid excessive compacting of the soil surface, especially when tracking, because soil compaction inhibits vegetation growth and causes higher runoff velocity. Therefore, it is best to limit roughening with tracked machinery to sandy soils that do not compact easily and to avoid tracking on heavy clay soils, particularly when wet. Roughened areas should be seeded as quickly as possible. Proper dust control procedures also should be followed when soil roughening.

There are different methods for achieving a roughened soil surface on a slope. The selection of an appropriate method depends on the type of slope and the available equipment. Roughening methods include stair-step grading, grooving, and tracking. Factors to consider when choosing a method are slope steepness, mowing requirements, whether the slope is formed by cutting or filling, and available equipment. The following methods can be used for surface roughening

Cut slope roughening for areas that will not be mowed. Stair-step grades or groove-cut slopes should be used for gradients steeper than 3:1. Stair-step grading should be used on any erodible material that is soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading. The vertical cut distance should be less than the horizontal distance, and the horizontal portion of the step should be slightly sloped toward the vertical wall. Individual vertical cuts should not be made more than 2 feet deep in soft materials or more than 3 feet deep in rocky materials.

Grooving. This technique uses machinery to create a series of ridges and depressions that run across the slope along the contour. Grooves should be made using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth on a front-end loader bucket. The grooves should be made more than 3 inches deep and less than 15 inches apart.

Fill slope roughening for areas that will not be mowed. Fill slopes with a gradient steeper than 3:1 should be placed in lifts less than 9 inches, and each lift should be properly compacted. The face of the slope should consist of loose, uncompacted fill 4 to 6 inches deep. Grooving should be used as described above to roughen the face of the slopes, if necessary. The final slope face should not be bladed or scraped.

Cuts, fills, and graded areas that will be mowed. Mowed slopes should be made no steeper than 3:1. These areas should be roughened with shallow grooves less than 10 inches apart and more than 1 inch deep using normal tilling, disking, or harrowing equipment (a cultipacker-seeder can also be used). Excessive roughness is undesirable where mowing is planned.

Roughening with tracked machinery. Roughening with tracked machinery should be limited to sandy soils to avoid undue compaction of the soil surface. Tracked machinery should be operated perpendicular to the slope to leave horizontal depressions in the soil. Tracking is generally not as effective as other roughening methods.

Limitations

Soil roughening is not appropriate for rocky slopes. Soil compaction might occur when roughening with tracked machinery. Soil roughening is of limited effectiveness in anything more than a gentle or shallow depth rain. If roughening is washed away in a heavy storm, the surface will have to be re-roughened and new seed laid.

Maintenance Considerations

Areas need to be inspected after storms, since roughening might need to be repeated. Regular inspection of roughened slopes will indicate where additional erosion and sediment control measures are needed. If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, they should be filled, graded again, and reseeded immediately. Proper dust control methods should be used.

Effectiveness

Soil roughening provides moderate erosion protection for bare soils while vegetative cover is being established. It is inexpensive and simple for short-term erosion control when used with other erosion and sediment controls.

Cost Considerations

Soil roughening is inexpensive with respect to cost of materials but requires the use of heavy equipment.

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Protect steep slopes

Geotextiles

Construction Site Storm Water Runoff Control

Description

Geotextile mats not only protect ground surfaces from wind and storm water erosion but also allow vegetative growth (Source: Rolanka International, 2000)

Geotextiles are porous fabrics also known as filter fabrics, road rugs, synthetic fabrics, construction fabrics, or simply fabrics. Geotextiles are manufactured by weaving or bonding fibers made from synthetic materials such as polypropylene, polyester, polyethylene, nylon, polyvinyl chloride, glass, and various mixtures of these materials. As a synthetic construction material, geotextiles are used for a variety of purposes such as separators, reinforcement, filtration and drainage, and erosion control (USEPA, 1992). Some geotextiles are made of biodegradable materials such as mulch matting and netting. Mulch mattings are jute or other wood fibers that have been formed into sheets and are more stable than normal mulch. Netting is typically made from jute, wood fiber, plastic, paper, or cotton and can be used to hold the mulching and matting to the ground. Netting can also be used alone to stabilize soils while the plants are growing; however, it does not retain moisture or temperature well. Mulch binders (either asphalt or synthetic) are sometimes used instead of netting to hold loose mulches together. Geotextiles can aid in plant growth by holding seeds, fertilizers, and topsoil in place. Fabrics are relatively inexpensive for certain applications. A wide variety of geotextiles exist to match the specific needs of the site.

Applicability

Geotextiles can be used alone for erosion control. Geotextiles can be used as matting, which is used to stabilize the flow of channels or swales or to protect seedlings on recently planted slopes until they become established. Matting may be used on tidal or stream banks, where moving water is likely to wash out new plantings. They can also be used to protect exposed soils immediately and temporarily, such as when active piles of soil are left overnight. Geotextiles are also used as separators; for example, as a separator between riprap and soil. This "sandwiching" prevents the soil from being eroded from beneath the riprap and maintains the riprap's base.

Siting and Design Considerations

There are many types of geotextiles available. Therefore, the selected fabric should match its purpose. State or local requirements, design procedures, and any other applicable requirements should be considered. Effective netting and matting require firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil, and erosion will occur underneath the material.

Limitations

Geotextiles (primarily synthetic types) have the potential disadvantage of being sensitive to light and must be protected prior to installation. Some geotextiles might promote increased runoff and might blow away if not firmly anchored. Depending on the type of material used, geotextiles might need to be disposed of in a landfill, making them less desirable than vegetative stabilization. If the fabric is not properly selected, designed, or installed, the effectiveness may be reduced drastically.

Maintenance Considerations

Regular inspections should be made to determine if cracks, tears, or breaches have formed in the fabric; if so, it should be repaired or replaced immediately. It is necessary to maintain contact between the ground and the geotextile at all times. Trapped sediment should be removed after each storm event.

Effectiveness

Geotextiles' effectiveness depends upon the strength of the fabric and proper installation. For example, when protecting a cut slope with a geotextile, it is important to properly anchor the fabric. This will ensure that it will not be undermined by a storm event.

Cost Considerations

Costs for geotextiles range from $0.50 to $10.00 per square yard, depending on the type chosen (SWRCP, 1991).

References

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Gradient Terraces

Construction Site Storm Water Runoff Control

Description


Terraces can be incorporated into the grading plan to shorten the length of the slope and to reduce the velocity of storm water flows (Source: Boaze et. al, 2000)

Gradient terraces are made of either earthen embankments or ridge and channel systems that are properly spaced and are constructed with an adequate grade. They reduce damage from erosion by collecting and redistributing surface runoff to stable outlets at slower speeds and by increasing the distance of overland runoff flow. They also surpass smooth slopes in holding moisture and help to minimize sediment loading of surface runoff.

Applicability

Gradient terraces are most suitable for use in areas with an existing or expected water erosion problem and no vegetation, and they are only effective when there are suitable runoff outlets provided. They are usually limited to use on long, steep slopes with a water erosion problem, or where it is anticipated that water erosion will be a problem. They should not be constructed on slopes containing rocky or sandy soil.

Siting and Design Considerations

Gradient terraces should be designed with adequate and appropriate outlets and should be installed according to a well-developed plan after conduction of an engineering survey and layout. Acceptable outlets include grassed waterways, vegetated areas, or tile outlets. Any outlet that is used should be able to redirect surface runoff away from the terraces and toward an area that is not susceptible to erosion or other damage.

General specifications require that:

- Whenever possible, vegetative cover should be used in the outlet.
- At the junction of the terrace and the outlet, the terrace's water surface design elevation should be no lower than the outlet's water surface design elevation when both are performing at design flow.
- During construction of the terrace system, dust control procedures should be followed.
- Proper vegetation/stabilization practices should be followed while constructing these features.

Limitations

Gradient terraces are not appropriate for use on sandy, steep, or shallow soils. If too much water permeates the soil in a terrace system, sloughing could occur, and cut and fill costs could increase substantially.

Maintenance Considerations

Regular inspections of the terraces should occur after any major storms and at least once a year to ensure that the terraces are structurally sound and have not been subject to erosion.

References

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Soil Retention

Construction Site Storm Water Runoff Control

Description

Soil retention measures are structures or practices that are used to hold soil in place or to keep it contained within a site boundary. They may include grading or reshaping the ground to lessen steep slopes or shoring excavated areas with wood, concrete, or steel structures. Some soil-retaining measures are used for erosion control, while others are used for protection of workers during construction projects such as excavations.

A permanent retaining wall prevents slope failure

Applicability

Grading to reduce steep slopes can be implemented at any construction site by assessing site conditions before breaking ground and reducing steep slopes where possible. Reinforced soil-retaining structures should be used when sites have very steep slopes or loose, highly erodible soils that cause other methods, such as chemical or vegetative stabilization or regrading, to be ineffective. The preconstruction drainage pattern should be maintained to the extent possible.

Siting and Design Considerations

Some examples of reinforced soil retaining structures include:

- *Skeleton sheeting*. An inexpensive soil bracing system that requires soil to be cohesive and consists of construction grade lumber being used to support the excavated face of a slope
- *Continuous sheeting*. Involves using a material that covers the entire slope continuously, with struts and boards placed along the slope to support the slope face - steel, concrete, or wood should be used as the materials
- *Permanent retaining walls*. Walls of concrete masonry or wood (railroad ties) that are left in place after construction is complete in order to provide continued support of the slope

The proper design of reinforced soil-retaining structures is crucial for erosion control and safety. To ensure safety of the retaining structure, it should be designed by a qualified engineer who understands all of the design considerations, such as the nature of the soil, location of the ground water table, and the expected loads. Care should be taken to ensure that hydraulic pressure does not build up behind the retaining structure and cause failure.

Limitations

To be effective, soil-retention structures must be designed to handle expected loads. However, heavy rains or mass wasting may damage or destroy these structures and result in sediment inputs to waterbodies. They must be properly installed and maintained to avoid failure.

Maintenance Considerations

Soil-stabilization structures should be inspected periodically, particularly after rainstorms, to check for erosion, damage, or other signs of deterioration. Any damage to the actual slope or ditch, such as washouts or breakage, should be repaired prior to any reinstallation of the materials for the soil-stabilization structure.

Effectiveness

Soil-retention structures, if properly designed and installed, can effectively prevent erosion and mass wasting in areas with steep slopes and erodible soils. Their potential for failure depends on their design, installation, maintenance, and the likelihood of catastrophic events such as heavy rains, earthquakes, and landslides.

Cost Considerations

Slope reduction can be accomplished during site development and might not incur any additional costs. Soil stabilization structures can be expensive because they require a professional engineer to develop a design (estimated to be 25 to 30 percent of construction costs [Ferguson et al., 1997]). Depending on the size of the proposed structure and the relief of the surrounding area, excavation and installation costs might be high. Capital costs include mobilization, grading, grooving, tracking and compacting fill, and installing the structures. Labor costs for regular inspection and repairs are also a consideration.

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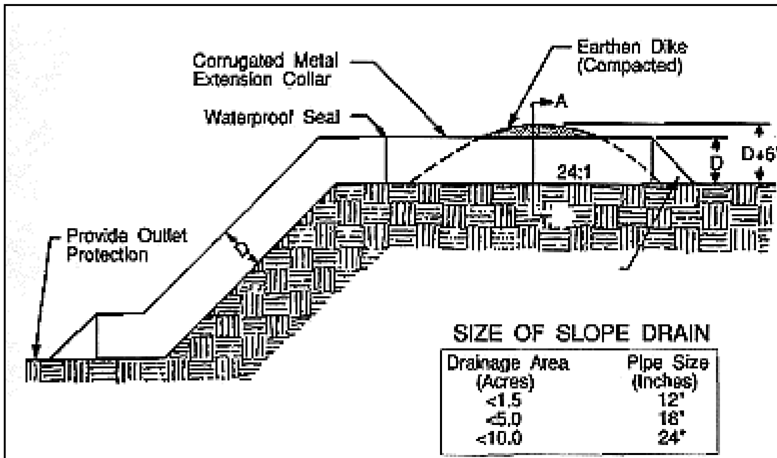
Temporary Slope Drain

Construction Site Storm Water Runoff Control

Description

A temporary slope drain is a flexible conduit extending the length of a disturbed slope and serving as a temporary outlet for a diversion. Temporary slope drains, also called pipe slope drains, convey runoff without causing erosion on or at the bottom of the slope. This practice is a temporary measure used during grading operations until permanent drainage structures are installed and until slopes are permanently stabilized. They are typically used for less than 2 years.



Drains can be installed along a steep exposed slope to divert runoff and prevent erosion (Source: Urban Drainage and Flood Control District, 1999)

Applicability

Temporary slope drains can be used on most disturbed slopes to eliminate gully erosion problems resulting from concentrated flows discharged at a diversion outlet.

Siting and Design Considerations

Recently graded slopes that do not have permanent drainage measures installed should have a temporary slope drain and a temporary diversion installed. A temporary slope drain used in conjunction with a diversion conveys storm water flows and reduces erosion until permanent drainage structures are installed.

The following are design recommendations for temporary slope drains:

- The drain should consist of heavy-duty material manufactured for the purpose and have grommets for anchoring at a spacing of 10 feet or less.
- Minimum slope drain diameters should be observed for varying drainage areas.
- The entrance to the pipe should consist of a standard flared section of corrugated metal; the corrugated metal pipe should have watertight joints at the ends; the rest of the pipe is typically corrugated plastic or flexible tubing, although for flatter, shorter slopes, a polyethylene-lined channel is sometimes used.
- The height of the diversion at the pipe should be the diameter of the pipe plus 0.5 foot.
- The outlet should be located at a reinforced or erosion-resistant location.

Limitations

The area drained by a temporary slope drain should not exceed 5 acres. Physical obstructions substantially reduce the effectiveness of the drain. Other concerns are failures from overtopping because of inadequate pipe inlet capacity, and reduced diversion channel capacity and ridge height.

Maintenance Considerations

The slope drain should be inspected after each rainfall to determine if capacity was exceeded or if blockages occurred. Repairs should be made promptly. Construction equipment and vehicular traffic must be rerouted around slope drains.

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