Classifying rolled erosion-control products: a current perspective

By Tim Lancaster and Deron N. Austin

Abstract

Strict local, state and U.S. federal water quality legislation has made engineers, architects, contractors and land owners more aware of their responsibilities to employ effective and economical erosion and sediment control practices.

On most construction sites, erosion control (the process of restraining the initial movement of soil particles by wind and water) is the most proactive and cost-effective way of complying with regulations. Exhaustive laboratory and full-scale field research has verified that "balanced" protection of the soil surface using permanent vegetation is an efficient and aesthetically pleasing form of erosion control.

This realization has created an industry dedicated to the manufacture of rolled erosion-control products (RECPs) designed to help mitigate immediate erosion-control problems and provide long-term soil stabilization through the establishment and maintenance of vegetative cover.

Common product terminology

During the past 10 years, terms such as "mulches," "erosion-control blankets" and "turf-reinforcement mats" have been used—sometimes even interchangeably—to define various classes of erosion-control products.

Although these terms may be understood by well-trained, erosion-control specialists, many engineers, designers and installers may become confused by the hierarchy of these product classifications and their intended applications.

A fundamental understanding of various engineered product categories is necessary to ensure their cost-effective specification and use. Since the generic classes encompass a wide variety of erosion-control materials, it makes sense that each category has a functional range of erosion control/revegetation applications.

Conventional mulching

Mulches have been used for decades for immediate seed and soil protection from erosive forces and to accelerate vegetation establishment. Benefits of mulches include

- assisting in soil stabilization, which immediately reduces wind and water erosion
- reducing soil temperatures, which decreases soil moisture evaporation and heat stress upon plants
- capturing and retains moisture, which reduces soil moisture loss
- capturing blowing snow, and increases the insulating effect of winter precipitation
- decomposing into valuable organic matter that becomes incorporated into the soil.

Loose mulches

Straw and hay are the most commonly used mulching materials. Loose straw and hay fibers, however, must be of sufficient length, 10 centimeters-20 centimeters, to interlock and offer the optimum mulch effect. The greater the fiber length of the mulch, the more effective the mulch is at providing these benefits. On flat to gently sloping terrain, dry mulches typically are machine applied at rates of 3,370 kg/ha - 4490 kg/ha (1.5 tons-2.0 tons/a) and anchored into the soil using dull-bladed coulter disks known as crimpers.

Tackifiers

As slope angles increase, crimping techniques are replaced by viscous oversprays, which are used to anchor the mulch fibers to themselves and to the ground. These oversprays, called "tackifiers," generally are composed of asphaltic emulsions; petroleum distillates; emulsions of co-polymer acrylates, latexes and polyvinyl acetates; and dry powdered vegetable gums derived from guar, psyllium and sodium alginase. Tackifier application rates vary depending on the type of product, severity of site conditions, climat and desired longevity of the installation.

Hydraulic mulches

In the 1960s, hydraulically applied mulches composed of wood, wood cellulose, paper pulp, recycled newsprint and/or cardboard fibers were developed as alternatives to conventional dry mulching techniques. These mulches offer the convenience of a one-step application whereby seed, fertilizer, soil amendments and the mulch can be applied in one pass by a hydraulic seeder/mulcher.

Hydraulic mulches, however, are hindered by a major limitation. The fibers generally must be less than 1.27 cm (½ inch) in length to pass through the pumps of the hydraulic seeder/mulcher. This greatly diminishes their derived mulching effect, even at application rates surpassing those of loose mulches. Though the years, extensive research and field experience has proven loose, long fibered mulches superior to hydraulic mulches for erosion protection and vegetation establishment.

Hydraulic mulches do have some advantages. The short fibers, coupled with their ability to absorb water during application, enable hydraulic mulches to readily adhere to steep slopes. The addition of tackifiers to the hydraulic slurry also can enhance the tenacity of the fibers. Hydraulic mulch applications generally are "cleaner" than other mulches that may be dry and dusty. The moisture the mulch retains during application may even stimulate seed germination. Quick seed germination, however, may be disastrous if the site does not receive enough precipitation to sustain seedling development. For these reasons, hydraulic mulches are most desirable for sites close to water or inaccessible to dry mulch blowers. They also may be best for more highly manicured environments where short-term aesthetics are a strong consideration.

Improved tackifiers and binding substances have been developed that bond tenaciously to the mulch fibers. New and improved bonded fiber matrices have shown impressive results in the laboratory, but tests under field conditions remain inconclusive.

All hydraulic mulches' longevity is limited by the retention of the matrix bond strength, which usually only lasts from one to four months. Hydraulic mulch bond strength may not develop if the site receives significant rainfall or freezing conditions within 24 to 48 hours of the installation.

Inclement weather may inhibit curing of the tacking agents, thereby rendering them ineffective even when more favorable conditions prevail. Bond strength also can be exceeded under increased runoff conditions on slopes and weakened in freeze-thaw conditions. Once the internal strength of the mulch is lost, the product's effectiveness depends upon the limited strength of the short, dimensionally unstable fibers. In most situations, hydraulic mulches cannot provide the performance of long-fibered mulches such as hay or straw. Because hydraulic mulches lack appreciable tensile strength, shear strength and a long life span, their use generally is limited to flatter and shorter slopes with very low overland flows.

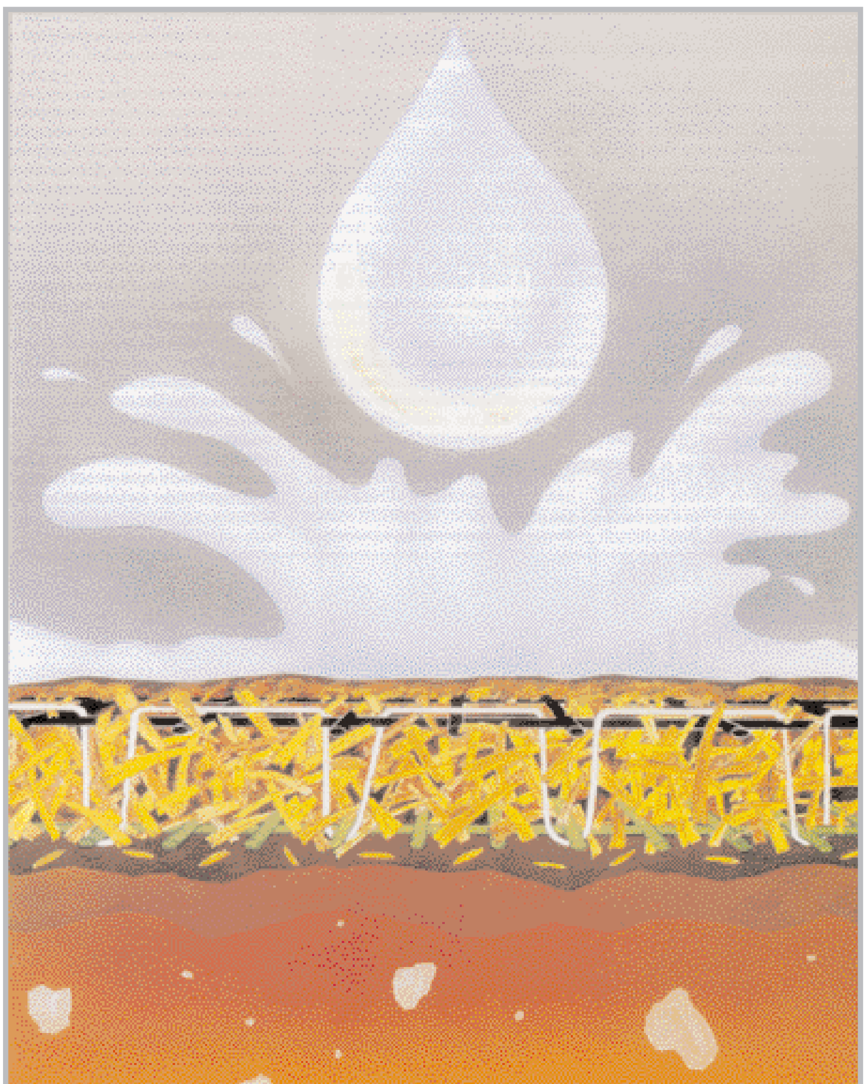

Figure 1. The most widely used erosion-control blankets are composed of fibers such as straw, wood excelsior, coconut, polypropylene or a combination thereof, stitched or glued to geosynthetic BOP nettings or woven natural fiber nettings.

Rolled erosion-control products

In the late 1960s, faced with the limitation of conventional mulching techniques, manufacturers initiated the development of what has become a diverse group of RECPs: erosion-control nets, open-weave geotextiles, erosion-control blankets and geosynthetic mattings. Manufactured from wood excelsior, straw, jute, coir, polyolefins, PVC and nylon, this growing family of materials enables designers to incorporate the superiority of long-fibered mulches with the tensile strength of dimensionally stable nets, meshes and geotextiles.

Erosion-control nettings

This class consists of two-dimensional, woven natural fibers or geosynthetic biaxially-oriented process (BOP) nettings used for anchoring loose fiber mulches such as straw or hay. Erosion-control nettings (ECNs) are rolled out over the seeded and mulched area and stapled or staked in place. Because they are not glued or stitched to the mulch, these nettings do not provide the same degree of structural integrity offered by prefabricated erosion-control blankets.

ECNs used along with loose mulch, however, generally provide increased performance compared with hydraulically applied mulches. This makes erosion-control nettings suitable for moderate site conditions where hydraulically applied mulches may not be stable, yet where open-weave erosion-control geotextiles and blankets are not necessary.

Open-weave geotextile meshes

Erosion-control meshes (ECMs) are woven or processed polyolefin yarns formed into a 2-D matrix. The closely woven construction of these materials enables them to provide erosion control with or without the use of an underlying loose mulch layer. Furthermore, these mesh typically display higher tensile strengths than most nettings. ECMs often are employed where higher strength is required, such as on steepened slopes or as a reinforcing underlay for sod. ECM also shows promise as an open-weave geotextile facing for geosynthetic-faced slopes on bioengineering installations, especially where woody plants are used as the natural stabilizing material.

Erosion-control blankets

Erosion-control blankets are constructed of various degradable organic/synthetic fibers that are woven, glued or structurally bound with nettings or meshes. The most widely used erosion-control blankets are made from straw, wood excelsior, coconut, polypropylene or a combination thereof stitched or glued to geosynthetic BOP nettings or woven natural fiber nettings.

This classification spans a very broad application range, since alterations in the fiber and netting components can instill various degrees of blanket effectiveness, durability and functional longevity. These materials, some available with seed pre-incorporated into their structures, are rolled out in intimate contact with the soil surface and anchored with staples, stakes and/or anchor trenches (**Figure 1**).

Erosion-control blankets are applicable on sites requiring greater, more durable and/or longer-lasting erosion protection. Applications include gradual to steep slopes, low to moderate flow channels and low-impact shore linings. Since these degradable materials are designed to provide temporary erosion protection, they generally are limited to areas where natural, unreinforced vegetation alone will provide long-term soil stabilization.

Geosynthetic mattings

Geosynthetic mattings consist of various UV-stabilized synthetic fibers and filaments processed into permanent, high-strength, 3-D matrices. Common examples include cuspated polyethylene meshes heat-bonded together extruded monofilaments of nylon or PVC heat-bonded at their intersections and crimped polyolefin fibers and other materials mechanically stitched between high-strength BOP nettings.

Geosynthetic mats are designed for permanent and critical hydraulic applications such as drainage channels, where design discharges exert velocities and shear stresses that exceed the limits of mature, natural vegetation.

These mattings' 3-D profile and high tensile characteristics function as a lofty

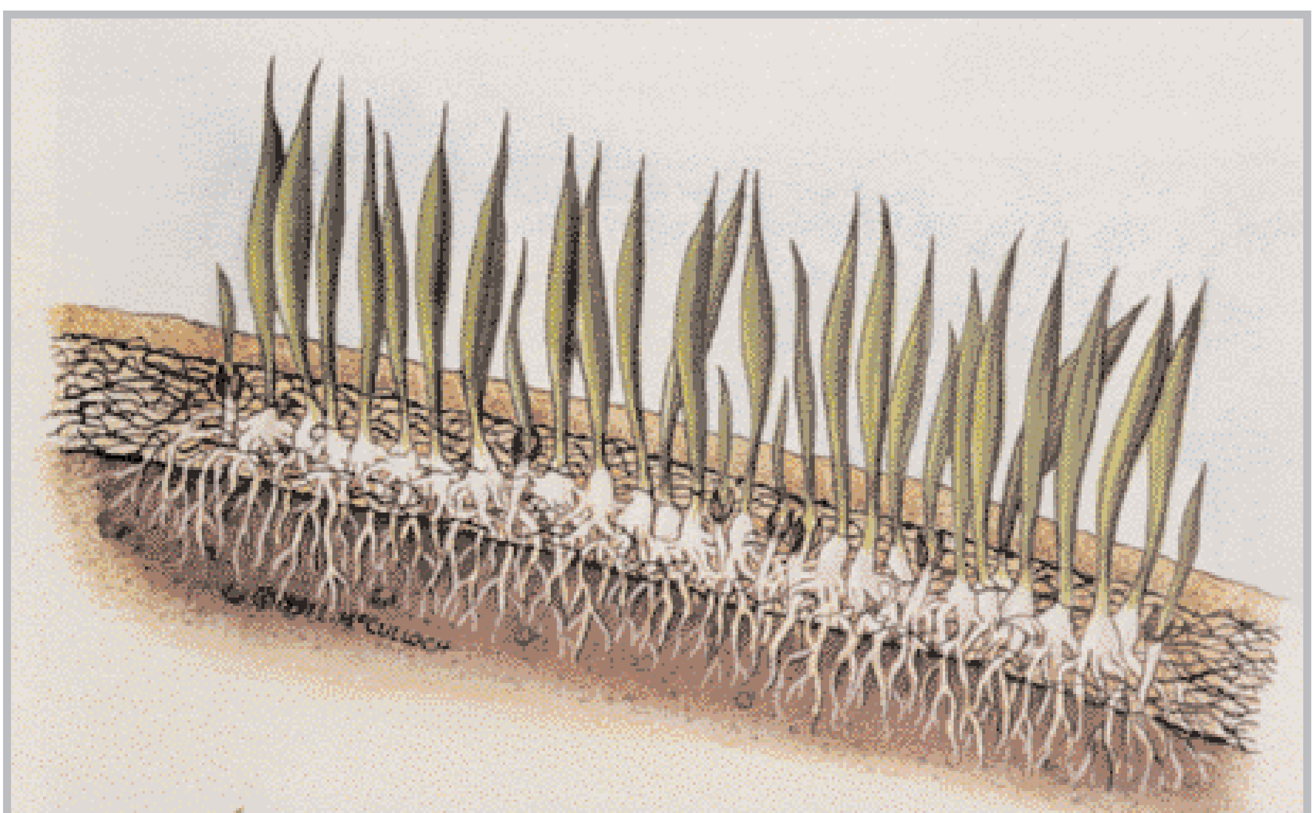

Figure 2. As opposed to erosion-control blankets, geosynthetic mattings are usually installed in a manner that best optimizes plant root interaction with mat structure. Typical installations involve rolling out and fastening the geosynthetic mat in intimate contact with the soil surface and in filling with fine soil and a prescribed seed mix.

matrix for entangling plant roots and soils. Together, they form a continuous composite—a unified, living mat. This synergism increases root systems' lateral strength, reducing plant dislodgement under high-velocity, high-shear stress flows. Reinforcing vegetation with geosynthetic mattings has become an acceptable, performance-proven, cost-effective and environmentally friendly alternative to rock riprap and other forms of nonvegetated lining materials.

Unlike erosion-control blankets, geosynthetic mattings usually are installed in a manner that optimizes plant root interaction with mat structure. Typical installations involve rolling out and fastening the geosynthetic mat in intimate contact with the soil surface, then in-filling with fine soil and a prescribed seed mix (**Figure 2**). A geosynthetic mat installed in this manner is called a turf reinforcement mat (TRM). Other geosynthetic mat installations involve direct deployment of the material over a freshly seeded soil surface. This allows the natural sedimentation process to in-fill the mat, allowing a more gradual development of a reinforced vegetated lining. A product installed this way is sometimes termed a permanent erosion-control revegetation mat (ECRM).

Industry standardization efforts

ECTC

The Erosion Control Technology Council (ECTC), an organization formed by RECP manufacturers, is developing classifications for open-weave geotextiles meshes, erosion-control blankets and turf reinforcement mats. Since these products span a wide range of both temporary and permanent erosion-control applications, an application-based classification system is a must. The ECTC, therefore, has established a performance-oriented classification system to help group these products. The ECTC system uses the following categories:

Low-velocity degradable RECPs

This category encompasses single-net organic fiber erosion-control blankets, biodegradable natural-fiber meshes and photodegradable geosynthetic meshes. Products within this class generally last one to two growing seasons and have a limited ability to resist damage and reduce erosion under severe conditions. They typically are recommended for slopes of moderate grade, length and runoff, as well as low-velocity channels where the potential for damage during installation and use is minimal.

High-velocity degradable RECPs

These materials are similar to low-velocity degradable RECPs in terms of installation and function but are designed for more severe site conditions.

High-velocity degradable erosion-control blankets are constructed with double-or high-strength nettings and/or increased quantities or different types of organic fibers. This construction results in heightened durability, effectiveness and, in some cases, longevity. Products in this class may have a functional life span of one to five years. High-velocity degradable blankets generally are used for steep slope protection and higher-velocity channel lining applications where natural, unreinforced vegetation still is expected to become permanent soil stabilization.

Long-term nondegradable RECPs

These materials' primary function is to provide permanent reinforcement of vegetation. These long-term, non-degradable, high-tensile strength geosynthetic mattings are used in critical erosion-control applications where immediate high performance erosion protection—to be followed by the permanent reinforcement of established vegetation—is required.

The ECTC continues to progress in index testing and performance standards. As new erosion-control blankets and mattings are introduced to the market, performance-oriented classifications will be refined as necessary. Categorization will likely become more detailed, focusing on properties such as permissible shear stress/velocity, installation stress, survivability and longevity.

IECA/ASTM

Other industry organizations also are involved in product classification development. The American Society for Testing and Materials (ASTM) D-35 Subcommittee is focusing on standards development for geosynthetic materials and test methods for erosion-control applications. Meanwhile, the International Erosion Control Association (IECA) is developing standard product classes for hydraulically-applied mulches, tackifiers, geotextiles, RECPs, riprap and gabions. Much like the ECTC's classification development, specific product categories for these materials will be created as index testing and performance research verify the need.

Conclusion

The importance of standardized product classifications for the erosion-control industry grows with the introduction and use of new products. Leading industry organizations are acting to develop standards as quickly as possible. To devise practical, working standards, these organizations need input from the specifiers and end-users of erosion-control materials. If you should be or would like to be involved in this process, please contact the ECTC and/or the IECA at these addresses:

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