Equestrian Design Guidebook

Chapter 6—Choosing Horse-Friendly Surface Materials

Although horses and mules are sure-footed in the wild, surfaces need to be carefully selected when developing trails and recreation sites. How well stock can walk on a surface depends on the degree of slope and traction, the horseshoes they are wearing, the distance they must travel, and the surface material itself.

Surface Options

When choosing surface materials, consider how comfortable and safe the surface is for the users and how well the material will stand up to the major forces that affect the surface's life:

- Compaction—the force pressing the material down, usually human, animal, and motorized users
- Displacement—the force moving material sideways
- Erosion—the forces of wind and water

All surface materials have advantages and disadvantages. For example, many materials present slipping hazards, especially when they are wet, snowy, or icy.

Whatever the choice, make sure the materials are appropriate for the regional climate and the level of development. For equestrian use, materials should be slip-resistant and able to withstand the impact of horseshoes. Paved surfaces provide little traction for horseshoes, and are not recommended. When the use of pavement is unavoidable, increase traction by using horse-friendly surface treatments.

The best surface material produces minimal dust and blends with the color of the native soil. Sometimes making the surfaces a different color helps users distinguish between areas, such as recreation site roads and parking spaces or parking pads.

Table 6–1 summarizes relative characteristics of common surface materials and table 6–2 identifies their relative suitability for horse trails and recreation sites. For discussion purposes, this guidebook categorizes surface materials as natural materials, aggregate, additives, and pavement. Specialty products and geosynthetic materials are listed separately.

Lingo Lasso

Course Outline

This guidebook uses the following terms to describe construction elements for trails and recreation sites:

- *Surface course*—The top layer of applied materials. The surface course carries the traffic load, provides a finished surface, is slip-resistant, and resists traffic wear and water damage.
- *Base course*—A support layer of applied materials. The base course provides the immediate support for the surface course. The base course may be built directly on the subgrade if no subbase is required.
- *Subbase*—A foundation layer used on engineered travelways. Recreation site roads and parking areas may require a subbase. Such construction must comply with the requirements of the AASHTO and ASTM International (formerly the American Society for Testing and Materials). The subbase consists of compacted granular material or soil that helps protect the base and surface courses from intrusion of finegrained roadbed soils, damage from frost, and the accumulation of free water in or below paved surfaces.
- *Subgrade*—The material in place; usually the natural soil. The subgrade is the base for succeeding layers of applied materials.

Table 6-1-Relative characteristics of common surface materials for horse trails, trailheads, and campgrounds. Specialty materials are not included. Agency specifications may vary.

	Surface material	Traction or slip-resistance*	Durability	Natural appea-rance**	Dust free	Horse comfort	Cost of material	Maintenance	Susceptibility to displacement
Natural materials	Native soil***	Variable	Variable	Excellent	Variable	Good to excellent	Low	Variable	Variable
	Wood chips	Fair to good	Poor	Good	Good	Excellent	Low	Moderate	High
Aggregate	Crushed rock with fines	Excellent	Excellent	Good	Good to excellent	Good	Moderate	Low	Low
	Crushed rock without fines	Good	Excellent	Good	Good	Fair	Moderate	Low to moderate	High
	Rounded gravel without fines	Poor	Excellent	Fair to good	Good	Poor to good (varies with particle size)	Moderate	Moderate	High
	Sand	Good	Good	Excellent	Poor	Good		Moderate	High
	Cinders	Good			Good	Poor		Moderate	High
Additives	Soil additives ****	Good	Good	Good	Good to excellent	Good	High	Moderate	Moderate
Pavement *****	Asphalt	Poor	Good	Poor	Excellent	Poor	High	Moderate	Low
	Asphalt with chip seal	Fair	Good	Fair	Excellent	Poor	High	Moderate	Low
	Rough textured concrete	Good	Excellent	Poor	Excellent	Poor	High	Low	Low
	Concrete with washed surface	Poor to fair	Excellent	Fair	Excellent	Poor	High	Low	Low
	Hard, traction friendly pavers	Good	Good	Poor to fair	Excellent	Poor	High	Moderate	Low

*** Wet surfaces may have reduced traction.**

**** How natural a product appears varies by location**

***** Native soils are quite variable. Consult local geotechnical engineers or soil scientists for more information.**

****** Characteristics of soil additives vary according to the manufacturer and the method of installation.**

******* Coatings and surface washes may change the characteristics of paved surfaces, including traction and appearance.**

Table 6-2-Suitability of common surface materials for equestrian trailheads and campgrounds. Specialty materials are not included. Agency specifications may vary. Note: Appropriate surface materials for arenas and round pens depend on the activities they're being used for. Consult other references for more details.

	Surface material	Roads	Packing areas and parking pads	Living areas (camp or picnic areas)	Horse areas, hitch rails, and wearing surfaces around water troughs	Wearing surfaces around water hydrants and wash racks*
Natural materials	Native soil**			X	X	
	Wood chips				X	
Aggregate	Crushed rock with fines	X***		X		
	Crushed rock with fines		X	X	X	X

	Rounded gravel without fines			X	X	X
	Sand					X
	Cinders	X		X		X
Additives	Soil additives***	X		X****		
Pavement*****	Asphalt					X
	Asphalt with chip seal					X
	Rough-textured concrete			X		X
	Concrete with washed surface			X		X
	Hard, traction friendly pavers					X

*** To reduce slipping hazards, use rubber mats in wash racks.**

**** Native soils are quite variable. Consult local geotechnical engineers or soil scientists for more information.**

***** The surface must be compacted.**

****** Soils treated with additives should not be used for tent pads.**

******* Coatings and surface washes may change the characteristics of paved surfaces, including traction and appearance.**

Natural Materials

As with all surface options, natural materials have advantages and disadvantages. Horse-friendly unpaved surfaces are attractive and well received by users. On the other hand, these surfaces may be damaged by rain or snow, and some, such as loose shale, round tree needles, damp moss, or moist vegetation, offer poor traction, posing slipping hazards for all recreationists.

Native Soils

Native soils vary, even within a single trail corridor. Soils that are coarsely textured with high percentages of gravel and sand can be very good surface materials for trails and *living areas*—defined camp and picnic areas. Finely textured soils, those with a higher percentage of organic matter, silt, and clay, tend to be poor surface materials. Roads, parking areas, and parking pads surfaced with native soils are generally difficult to maintain and can become muddy. Hoofs, boots, and wheels can damage the tread in wet or boggy areas (figure 6–1). When these areas dry out, the ruts may make the area difficult to use. Some native soils also produce a lot of dust, an issue of special concern in urban areas and near residences. Unhealthy dust conditions may require abatement measures. Native soils may be economical, but they may require frequent maintenance, reducing their overall cost effectiveness.

Figure 6–1—As trail surfaces become worn or muddy , trail users frequently walk to the outside. This results in wider or multiple treads that are often called *braided trails*.

Resource Roundup

Soil Treatments for Accessible Trails

Soil Stabilizers On Universally Accessible Trails (Bergmann 2000) reviews several products that claim to stabilize native materials used for trail surfaces while maintaining a natural appearance. Results varied from very poor to satisfactory stabilization. The report is available at http://www.fhwa.dot.gov/environment/fspubs/00231202 or http://www.fs.fed.us/t-d/pubs/pdf/00231202.pdf. This Web site requires a username and password. (Username: t-d, Password: t-d)

Wood Chips

Wood chips cushion the impact of hoofs on soils, and most stock are comfortable walking or lying on them. Consider using wood chips about 2 by 2 by ½ inches (51 by 51 by 13 millimeters) on low development trails in drier climates. In areas where horses are confined, smaller chips or sawdust are suitable in many climates. Hardwood chips may last longer than chips from conifers.

Wood chips require more maintenance than other materials. They absorb water and eventually decompose and become embedded in the soil surface. Heavy rainfall can wash the chips away unless they are contained with edging. Wet wood chips can be slick, making them less desirable in regions that have steep grades or heavy use. Wood chips also can blow away, harbor insects, retain unwanted moisture, and reduce accessibility. Chips with protruding knots can injure the horse's frog if the animal is not wearing horseshoes. Don't use chips from trees that are toxic to horses and mules, such as black walnut or yew.

Resource Roundup

Accessible Surface Study

The National Center on Accessibility is conducting the National Trails Surface Study to determine which trail surface materials are accessible as well as environmentally friendly. More information is available at http://ncaonline.org.

Aggregate and Similar Surface Materials

The term *aggregate* generally refers to materials that started out as bedrock. Aggregate is commonly used for base and surface courses at recreation sites and on trails. Aggregate includes combinations of crushed stone, gravel, crushed gravel, sand, or other mineral materials. Aggregate is produced using crushing, screening, pit-run, or gridrolling methods. Crushing and screening are the most commonly used methods. Pit-run and grid-rolling methods generally produce lower quality aggregate.

- *Crushing* breaks stone and gravel into smaller particles. Crushing equipment also blends the various sizes together for the proper gradation.
- *Screening* separates raw material into uniform sizes. The material is moved or shaken on sorting screens. Adjusting the relative proportion of particle sizes produces the proper gradation.
- *Processing* is not required for pit-run aggregate, because aggregate in its natural state has the proper gradation of particle sizes. Sometimes, oversized stones are sorted out using a *grizzly*—a screen with large openings.
- *Grid-rolling* means crushing rock in place. Rock sources include native materials or aggregate hauled from pits. A heavy steel roller with a waffle pattern rolls the material, crushing and compacting it at the same time.

Aggregate can be graded for base and surface courses. Gradation refers to aggregate particle sizes and the relative distribution of those particle sizes in the material. *Well-graded soils*—those with many particle sizes—compact well. Gradation is determined by screening—or *sieving*. A sample of the test material is dried, weighed, and then passed through a series of sieves. The contents of each sieve are weighed.

Well-graded aggregate has a mix of particle sizes that fit snugly together to form a tight, dense mass. Water for lubrication is added during construction, allowing the particles to be thoroughly compacted so they form a relatively stable surface. The suitable depth for an aggregate surface course varies depending on soil conditions and the depth of the base course.

Other materials that occasionally are used in aggregate base and surface courses include fillers or binders and chemical additives. Fillers are mineral materials, such as crushed limestone, that improve the gradation of the aggregate. Binders increase the cohesiveness or binding quality of the aggregate. Clay is a common binder. For example, a base of sand and clay is often used in areas with abundant sand. The sand alone is too loose to form a well-compacted stable material. Adding small amounts of clay to aggregate may improve resistance to washboarding and raveling. Fillers and binders generally are not used alone but are blended uniformly with the aggregate. Added materials should be blended at the plant when the aggregate is processed.

Lingo Lasso

Screens and Sieves

The terms *screen* and *sieve* are often used interchangeably. A sieve is a pan with a square woven wire mesh—the screen—at the bottom. The size of a sieve depends on the size of the mesh openings. The most commonly used soil classification system is the Unified Soil Classification Systems (USCS). The USCS labels sieves with large openings as 4-inch, 3-inch, 2-inch, ¾-inch, 3/8-inch and so forth. Metric equivalents are about 101.6-millimeter, 76.2- millimeter, 50.8 millimeter, 19-millimeter, and 9.5-millimeter sieves. USCS uses the U.S. Standard Sieve Numbers for sieves with smaller openings:

- No. 4 U.S. Standard Sieve—4.750 millimeters (about 0.187 inch)
- No 10 U.S. Standard Sieve—2.000 millimeters (about 0.079 inch)
- No. 20 U.S. Standard Sieve—0.850 millimeter (about 0.033 inch)
- No. 40 U.S. Standard Sieve—0.425 millimeter (about 0.017 inch)
- No. 60 U.S. Standard Sieve—0.250 millimeter (about 0.010 inch)
- No. 100 U.S. Standard Sieve—0.150 millimeter (about 0.006 inch)

- No. 140 U.S. Standard Sieve—0.106 millimeter (about 0.004 inch)
- No. 200 U.S. Standard Sieve—0.075 millimeter (about 0.003 inch)

Gravel

Gravel is a coarse, granular material produced by the natural weathering and erosion of rock. The USCS distinguishes gravel as particles that pass through a 3-inch (76.2-millimeter) sieve but remain on a No. 4, 0.187-inch (4.750-millimeter) sieve. Particles larger than 3 inches (76.2 millimeters) are considered cobbles and boulders. Round gravel usually comes from alluvial deposits. Sometimes round gravel is used in wildland settings or areas with low development where it is readily available. Round gravel with very small rocks sometimes is called pea gravel. Pea gravel is appropriate for surfaces in horse areas and around hydrants, water troughs, and wash racks. Round or pea gravels are poor choices for trails, roads, parking areas, and parking pads because they don't compact well. The rocks roll against each other, making it difficult for people and stock to walk. Vehicles pulling a trailer also have difficulty getting traction, especially if the gravel is deep. As the gravel particles roll, the vehicle sinks and may become stuck.

Crushed Gravel and Crushed Stone

Crushing natural gravel produces crushed gravel. The number of fractured faces depends on the original gradation of the natural gravel—the coarser the gradation, the higher the percentage of fractured faces.

Crushed stone is produced by crushing bedrock. Nearly all the faces of the fragments are fractured. Examples of materials used for crushed stone include limestone and granite.

Many people refer to crushed gravel and crushed stone, either separately or in combination, as *crushed rock*. Crushed rock, with its angular faces, compacts relatively well. Crushed rock is suitable for trail areas where water collects or where there is heavy use. It is also suitable for subbases on roads, parking areas, parking pads, and trails. Crushed rock can be used in horse areas and as surface courses on parking areas and parking pads. Stock are more comfortable lying down on crushed rock than on harder surfaces. Small rocks ⅜ inch (about 9.5 millimeters) or smaller are less likely to get caught in rakes during manure cleanup. Larger rocks can lodge in an animal's hoofs, causing pain or injury. Crushed rock is suitable near water, for example on wearing surfaces around water hydrants, water troughs, and wash racks.

Crushed rock, when combined with fines and well compacted, generally is preferred for surface courses on trails, roads, and living areas. This material fits together tightly, offering a stable surface for pedestrians, stock, and vehicles. Compacted crushed rock with fines withstands high use and requires little maintenance. The material provides good traction and drainage. If it is well compacted and the surface hardens well, it is not dusty. The standard size for crushed material is ¾-inch-minus (less than about 19.1 millimeters), which includes rocks about ¾ inch in diameter and smaller. Some agencies prefer crushed materials that are ½-inch-minus (about 12.7 millimeters or less) for trail building, but this material may be more expensive.

Horse Sense

Crusher Fines

Fines—sometimes called *crusher fines*—are small particles of crushed rock that include a mix of sizes, from a fine dust up to ⅜ inch (about 9.5 millimeters) in diameter. Often, crusher fines are leftovers from crushing operations, but they can be custom produced. Using crusher fines alone contributes to dusty conditions. Wellgraded crusher fines mixed with a clay binder can form a good surface for trails or living areas in campgrounds. Crusher fines frequently are added to crushed rock to make the mixture compact more completely. The recommended combination of crusher fines and crushed rock contains enough small particles to completely fill the voids between larger rocks.

Sand

Sand is fine granular material produced by the natural disintegration of rock. The USCS says that sand is material that passes a No. 4 (4.750-millimeter) sieve, but is retained on a No. 200 (0.075-millimeter) sieve. Sand drains well and creates a soft trail tread for stock. When used alone, sand is easily eroded or replaced by other materials and can be dusty. Often, sand is combined with clay and gravel or other materials to improve its drainage or prevent too much compaction. If sand is applied more than 3 inches (76.2 millimeters) deep, it can strain an animal's tendons and ligaments. Over time, horses that eat or breathe sand can contract sand colic, a serious illness. Sand should not be used in areas where horses and mules eat or where they spend a lot of time.

Decomposed Granite

Decomposed granite resembles crushed stone, although it erodes into angular pieces through natural processes. Decomposed granite, with or without fines, compacts relatively well. When combined with fines and compacted, decomposed granite is a popular surface choice for trails, parking areas, parking pads, and living areas in campgrounds. Some designers group crushed stone, crushed gravel, and decomposed granite under the single term *angular rock* because these materials have many characteristics in common. All are excellent for many surfaces used by horses and mules.

Cinders

Cinders are pulverized pieces of volcanic lava about ½ inch (13 millimeters) in diameter or smaller. They are an alternative treatment for high-use areas that are subject to trenching or soil displacement caused by water, snow, or ice. The rough surface provides improved traction but requires periodic maintenance to replace displaced or buried materials. Cinders form an unpleasant walking surface for long-distance trails.

Additives

Soil additives reinforce or augment existing soil structure to improve the soil's engineering characteristics. They can be used to improve some native soils and leave them looking natural. Some additives also may be used with well-graded aggregate. Several commercial companies market additives described as environmentally friendly that produce firm surfaces.

Chemical additives—calcium chloride, sodium chloride, lignin sulfonate, magnesium chloride, or hydrated lime—may be added to aggregate to control dust, to adjust moisture levels, or to act as a binder. Sometimes, a small amount of portland cement is mixed with soil or aggregate to slightly harden the surface. *Soil stabilizers*—a form of additive—act as a binding agent. After a rainfall, some stabilized materials may fail to adequately support the weight of stock. AASHTO or ASTM International specifications establish standards for many additives.

Pavement

This guidebook uses the term *pavement* to refer to hardened materials such as asphalt, concrete, and hard pavers. Although they are durable, hardened materials frequently are not horse friendly.

Pavement usually is smooth, offering poor traction for horseshoes. Most equestrians are uncomfortable riding, unloading, or tying their stock on pavement. For example, a horse stepping out of a trailer may slip once its weight hits the smooth surface. Some stock balk at the trailer door when they are being loaded. As the handler works to get the animal inside, a smooth surface makes a difficult situation dangerous.

There are other reasons for avoiding pavement in areas used by riders. When horses and mules are comfortable, they are more likely to stay quiet. Stock may spend many hours tied to trailers or confined in corrals, and they are more comfortable standing on softer surfaces.

Pavement is inherently dangerous for stock. If pavement in a stock area is absolutely unavoidable, minimize the paved area. Horses and mules can successfully navigate short sections of smooth surface if they are accustomed to doing so. However, many stock are reluctant to step on unfamiliar or uncomfortable surfaces.

Because pavement does not absorb liquids, urine and rainwater can form puddles. Standing puddles of horse urine are a nuisance for pedestrians, and may make the surface slippery.

Asphalt

Asphalt surfaces generally are not recommended for horse trails, parking areas, or parking pads because they provide little grip for horseshoes. However, trails may have to cross sections of asphalt. Use alternate materials or treat the surface to increase traction. Uncoated asphalt surfaces are somewhat rough, providing a degree of traction that is better than coated asphalt. *Rubberized asphalt*—regular asphalt mixed with finely ground used tires—provides more traction and has been used with some success in Arizona. Caution: asphalt heats up and softens in extremely hot climates. The softened material sticks to hoofs and can burn the living tissue under some circumstances.

Trail Talk

Sticking to It

Horses and mules need traction even when they're not on the trail. For example, when the Northern Region Pack Train participated in the Rose Bowl Parade, the horses and mules each wore special horseshoes. Welded to the gripping surface of each shoe was a slip-resistant borium coating. Many sponsors of large events require the use of borium-treated horseshoes to reduce risk.

Asphalt With Chip Seal

Asphalt with a chip-seal finish may slightly improve traction on asphalt road surfaces. This option is suitable for limited use at trail crossings, bridges, and bridge approaches. Type III asphaltic emulsion slurry seal may be an option.

Resource Roundup

Slip-Resistant Slurry

To reduce the potential for slipping by humans and stock, the Forest Preserve District of DuPage County, IL, surfaced the equestrian parking lot at Waterfall Glen Forest Preserve with a Type III asphaltic emulsion slurry seal. The seal uses larger aggregate and is applied in a thick layer. The result is a coarse surface texture that improves traction for all users. In other areas of the country, the treatment is commonly referred to as slurry seal or slurry surfacing.

Slurry seal emulsion is comprised of well-graded fine aggregate, mineral filling (if needed), emulsified asphalt, and water. Type III slurry seal is usually used as the first of many coatings, to correct surface conditions, or to improve skid resistance. Technical information is given in *Supplemental Specifications and Recurring Special Provisions* (Illinois Department of Transportation 2005) at http://www.dot.il.gov/desenv/07supp.pdf.

Rough-Textured Concrete

Concrete is one of the slipperiest surfaces a horse or mule may encounter, and many riders do not recommend it. Nonetheless, stock manage to cross concrete surfaces without incident. This doesn't make concrete any safer. A heavy, rough-broom finish, applied perpendicular to the direction of travel, is one mitigation measure used successfully in some places. A rough finish may increase traction, but does not eliminate the danger that a horse or mule might slip and fall on the hard surface.

Concrete With Washed Surface

Concrete, with exposed 1- to 1½-inch (about 25- to 38-millimeter) crushed aggregate and a ½- to ¾- inch (about 13- to 19-millimeter) water wash finish, provides more traction than smooth concrete (figure 6–2). Riders do not agree on the advisability of using this finish. Local weather, site conditions, or top coatings can reduce surface traction. For example, the surface may be slippery when wet, especially if a sealer coat has been applied. Before choosing this surface treatment, consult with local horse riders.

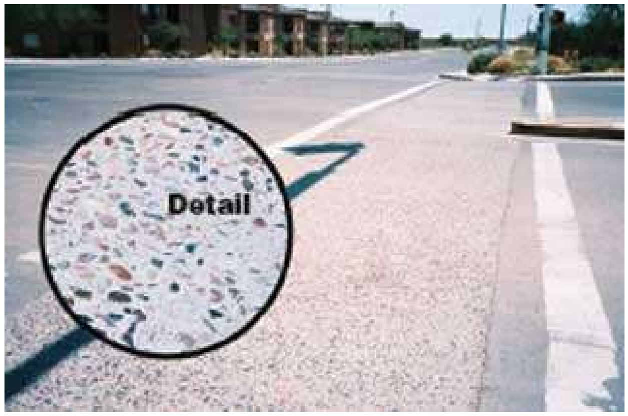

Figure 6–2—Some agencies use concrete surfaces with a water wash finish to improve horse traction. This treatment may not be suitable in all areas.

Pavers

Generally, hard pavers are not horse-friendly surfaces. However, interlocking or articulating pavers that facilitate traction can be good choices for equestrian water crossings where stream erosion is a problem. Interlocking pavers fit into each other, holding them in place. Some styles allow vegetation to grow through, others have voids that can be filled with soil, gravel, or other suitable material. Articulating concrete pavers form a mat with spaces that are filled with soil. In highly erodible soils, pavers combined with geotextiles are an option. These materials provide a horse-friendly choice for durable surfaces, but they are costly.

Synthetic or rubberized pavers are softer than many other pavers, slip-resistant, and costly. These pavers come as interlocking pieces or regular shapes that require adhesive to hold them in place. Suitable locations for these pavers include trails, approaches to bridges, culverts, on roads with grades steeper than 5 percent, and on wearing surfaces for hitch rails, water troughs, and wash racks. They also may be suitable in urban and rural areas on unpaved treads that are dusty or drain poorly. Some areas have had problems keeping the interlocking pavers in place.

Trail Talk

In the Groove

It is dangerous for stock to travel on smooth, hard surfaces. Some people suggest *grooving*—or *tining*—concrete to provide more traction. According to *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects* (FP–03) (FHWA 2003), grooves in textured concrete are spaced about 0.4 to 0.8 inch (10.2 to 20.3 millimeters) on center, are about 0.08 to 0.20 inch (2 to 5.1 millimeters) wide, and about 0.12 to 0.20 inch (3 to 5.1 millimeters) deep. Grooves should be perpendicular to the direction of travel. Form grooves using a float with tines or a concrete saw. Grooves on horse trails should not be larger than specified because:

- Horseshoes with built-up heels and toes can catch in large grooves.
- Large grooves reduce the amount of surface that contacts the hoof, giving less traction.
- Surfaces with grooves deeper than 0.5 inch (12.7 millimeters) don't meet accessibility requirements.

Roads with grooved areas, rumble strips, and similar treatments must comply with applicable requirements, such as AASHTO standards. Rumble strips are not recommended for areas used by stock.

Grooved surfaces may require frequent maintenance to keep the grooves free of debris. When the grooves are filled, they won't provide traction.

Specialty Products

Antiskid planking and sheeting made from recycled tires and plastics are used in marine environments and may be useful for equestrian bridge applications. The materials originally were designed for horse trailer ramps, floors, and walls.

Heavy-duty stall mats or rubber matting made from recycled tires may be suitable for wash racks or other wet areas. The mats reduce mud, improve traction, and are comfortable for stock. Bolt the mats down to prevent them from moving or from being stolen. Many commercial manufacturers make these products.

Geosynthetic Materials

Geosynthetics are synthetic materials, usually made from hydrocarbons. Geosynthetics in combination with soil or rock can increase tread stability.

Geosynthetics perform three major functions: separation, reinforcement, and drainage. Materials of this type include geotextiles and cellular confinement products, such as geocells. These materials become a permanent part of the trail. They are covered with about 6 inches (152 millimeters) of soil or rock to prevent damage by ultraviolet light or users.

Geotextiles

Geotextiles, also known as *construction fabrics* or *filter cloth*, are widely used in roads, drains, and embankments. They consist of long-lasting synthetic fibers bonded by weaving, heat, extrusion, or molding. Geotextiles stabilize surfaces when they are used with other materials or vegetation. They are not suitable for use alone as tread. Figure 6–3 shows construction of a trail tread using geotexile covered with several layers of gravel.

Figure 6–3—Geotextile is sandwiched between a substandard soil base and an aggregate cap to prevent soil migration. Logs hold the edges of the fabric in place.

Cellular Confinement

Cellular confinement systems (CCS) are three-dimensional, web-like materials that provide structural integrity for materials compacted within the cell. The engineered cell walls limit the transfer of shear forces within the soil. CCS consists of a surface-aggregate wearing surface, the cell membrane, and fill—usually imported gravel or suitable onsite material. Depending on site characteristics, construction may incorporate an optional separation fabric. Installation of the system is labor intensive. The smallest cell system commercially available is 4 inches (102 millimeters) deep. At least 6 inches (152 millimeters) of fill is required to plug the cells and provide a 2-inch (51-millimeter) wearing surface. For a 6-foot- (1.8- meter-) wide trail, this amounts to about 1 cubic yard (0.76 cubic meter) of loose material per 6 linear feet (1.8 meters) of trail. Figure 6–4 shows a trail bridge approach that is being reinforced with CCS and soil. Figure 6–5 shows the finished job.

Resource Roundup

Geosynthetics in Wet Areas

For more information regarding the use of geosynthetic materials in wetlands, refer to Geosynthetics for Trails in Wet Areas (Monlux and Vachowski 2000). View the report at http://www.fhwa.dot.gov/environment/fspubs/00232838 or http://www.fs.fed.us/t-d/pubs/htmlpubs/htm00232838. This Web site requires a username and password. (Username: t-d, Password: t-d)

Figure 6–4—Workers are preparing the third layer of geocells at a trail bridge approach. The cells provide structure for soil that forms the tread.

Figure 6–5—When installation is completed, the approach blends into the surrounding landscape.

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