SMARTER SITE WORK WITH Geosynthetics

Use these versatile materials to reduce erosion, improve drainage, and boost the bearing capacity of the soil

by Ted Cushman

Excavation and site work are an important cost category on many construction jobs. Early in the job, they're also a major unknown — you can never be absolutely sure what's down there until you start digging.

Those underground unknowns can also mean unexpected costs. Installing drainage for a wet soil, excavating and replacing a weak soil, or simply compacting a difficult soil can add days to the schedule and strip big dollars off the bottom line. Soil erosion that pollutes waterways or clogs storm drains can bring on major penalties, or even shut down the job. And when you think the job's long over, site work can come back to haunt you: Problems and failures related to soil issues top the list of expensive callbacks and claims.

Given all that, builders are glad to hear about any technology that can take some of the uncertainty out of earth work. In recent years, answers are coming from a new class of products known as "geosynthetics." Tough plastic fabrics, grids, and cells are helping to handle all kinds of soil-related concerns. With the right product, you can

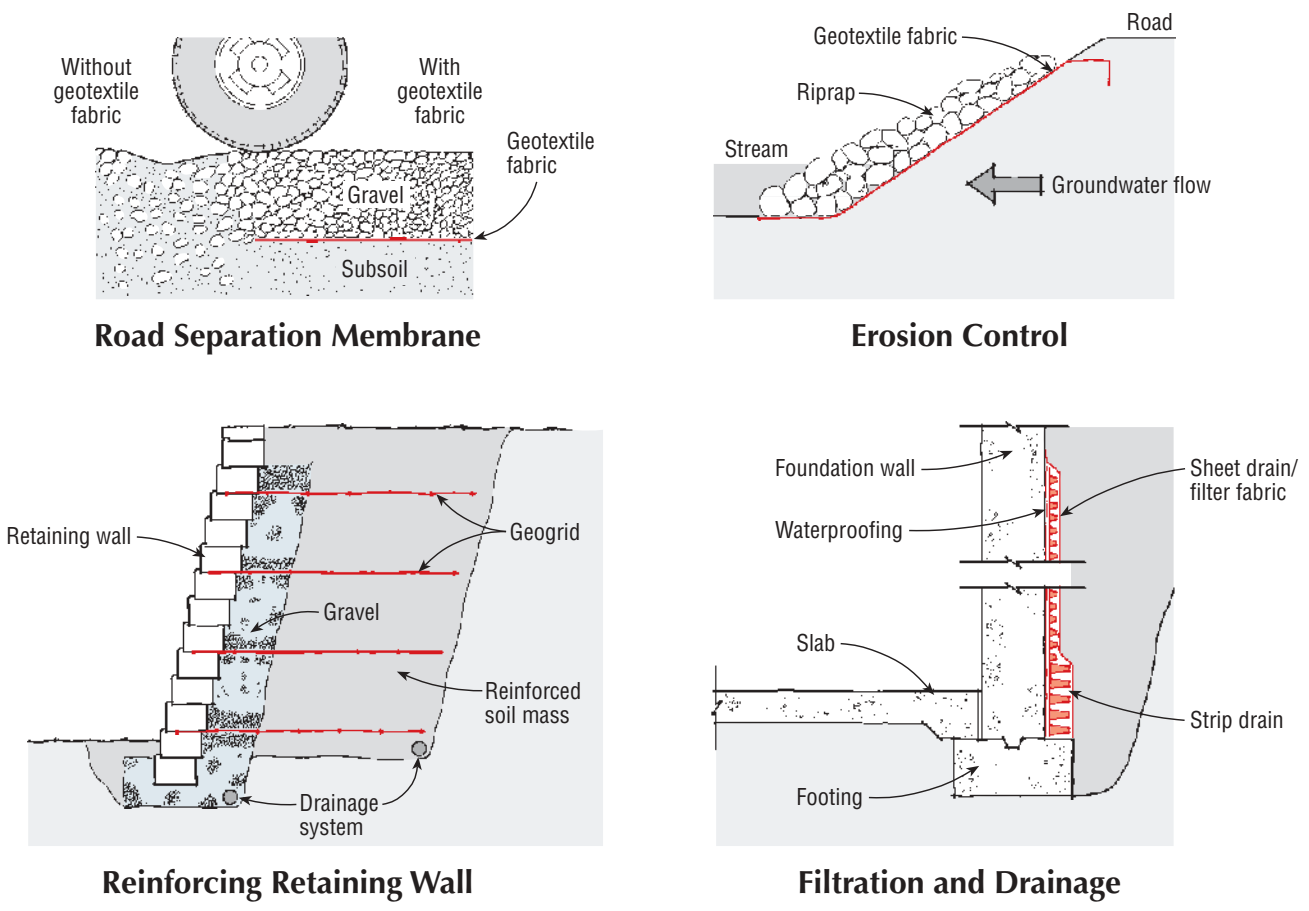


Figure 1. The range of uses for geosynthetics continues to expand as companies develop new materials and customers find new applications. Most soil engineers now recognize the value of geotextiles for separating gravel from soft subsoil (top left) and holding soil in place against water action (top right). Geogrids have proven their value as a reinforcing element in earth-retaining walls (above left), and geocomposite drainage systems are gaining popularity because of their simplicity and effectiveness (above right).

reduce erosion, improve drainage, stabilize slopes, and boost the bearing capacity of soil — often at a fraction of the cost of placing sand and gravel or casting reinforced concrete.

There are now dozens — maybe hundreds — of geosynthetic products on the market. Some are geared mainly to commercial or industrial construction, although they're occasionally used by residential builders as well. Others, like woven-poly silt fencing and the filter fabric wrapped around gravel drains, have become commonplace and are on the shelves at every lumberyard.

Problems and Solutions

Geosynthetics can solve a wide range of problems, but most of those problems fall into a few broad areas (see Figure 1).

Separation. When you mix gravel and mud, you don't get more gravel — you get more mud. Fabrics placed between a gravel roadbed and soft underlying soils keep traffic from driving the gravel down into the mud, or "pumping" mud up into the gravel. This maintains the gravel's drainability and strengthens the road or driveway, prolonging its life.

Reinforcement. Different soils have different properties, but no soil on earth has any tensile strength to speak of. Synthetic fabrics or grids can introduce a tensile component into the equation: They distribute forces sideways through the soil and prevent soil from slumping, slipping, or compressing. The result is a stronger subgrade with less fill or compaction work, or a steep stabilized bank with no expensive concrete work.

Filtration. Silt washing out of fine soils can quickly clog foundation drains or even municipal storm drains.

Tenax

Figure 2. Geotextiles have become a commodity product, with many companies competing to provide choices across the whole range of strength, porosity, and other properties. Silt fences (left) and filter wraps for trench drains (right) are familiar uses to most builders.

Figure 3. For roads ranging from temporary access roads to superhighways, tough woven fabrics isolate the gravel road base from soft soil subgrades, stabilizing the road structure and dramatically prolonging its life.

BBA Nonwovens

Synthetic filter fabrics block the silt and let the water through, protecting permanent drains and keeping site runoff from polluting streams and ponds.

Drainage. All soils perform best in a well-drained condition. Placed appropriately, a thin synthetic sheet product weighing just ounces a yard can replace tons of granular fill as a drainage medium. Composite products — filter fabrics wrapped or laminated over a free-draining center — make a fast-draining assembly that is cheap, effective, and quick to install.

Erosion control. Federal and state regulators are getting tough on silt-laden runoff from construction sites. To comply with strict permit provisions, builders need to use "Best Management Practices" (BMPs) that can stand up to regulatory scrutiny. Natural and synthetic fabrics are an important part of the strategy to keep soil from washing off slopes, to trap silt that does run off, and to protect seeds and help quickly revegetate exposed earth.

Fabrics

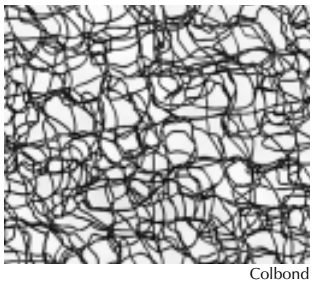
Geotextile fabrics were the first geosynthetic product, and they're still the most common, at least in residential work. They're also highly versatile. Geofabrics can be engineered to provide solutions to all of the project categories just mentioned, from separation of soil and fill to erosion control (Figure 2). Some varieties are woven from spun yarn, some are woven from "slit film" strips cut from sheets of plastic, and some are nonwoven — spun-bonded or laid down in a mass and formed into a sheet with heat, pressure, or chemical action. Some, especially the very open-weave fabrics made with heavy, stiff fibers, are "needle-punched" — tangled together mechanically by barbed needles.

Picking the right fabric. Geotextiles are a commodity item — most companies that have geotech materials can offer the whole range of fabrics for any need, and although comparable products from competing manufacturers may be constructed differently, they have to live up to the same industry standards. Companies publish values for important traits like tensile strength, puncture resistance, pore size, flow rate, and chemical resistance. Price and availability may affect the final choice, but geotech professionals generally try to match a product's characteristics to the role it has to play on a case-by-case basis.

For reinforcement under a road, for example, strength and toughness are key considerations (Figure 3). For simple filtration, on the other hand, a high flow rate and the correct pore size may be more important. Many designers take the short cut of following some sort of standard spec (state departments of transportation publish lists of "prequalified" products that are accepted for specific uses under given conditions). But the choices aren't simple: The nature of the site soils as well as the product can affect performance. If your application is at all demanding, it's wise to consult an engineer.

Beyond bales. Although they're still useful in many applications, silt fences

Figure 4. Tangled open-weave fabrics made from heavy plastic strands (right) provide a tough anchorage for plants to resist stormwater erosion and trap silt. Wrapping heavy fabrics around soil on an exposed river or lake bank can hold the bank in place and help plants stay anchored (below).



Colbond

SI Geosolutions

and hay bales are no longer the state of the art in temporary erosion control. And for permanent installations, riprap and concrete culverts are old hat. Modern geosynthetics, and natural-fiber erosion control blankets with or without synthetic reinforcement, are doing the job more effectively and often at less cost (Figure 4). The tougher geofabrics can serve as a permeable undercourse to heavy concrete or stone armor to protect shores against waves and currents; seawalls made with this system can outlast rock-only systems by decades. Heavy open-weave fabrics can anchor vegetation in swales to create natural "living armor" that protects better than stone or concrete, and also captures silt and other pollutants effectively.

The more complex permanent measures are engineered applications, but many temporary measures are simple. Any good landscaping supply house can point you to natural or synthetic products that will protect the area around your job site from silt-laden runoff.

Geogrids

Heavier open meshes of tough plastic called geogrids provide even greater strength and are used mostly

Tensar

Clark & Green Architects

Figure 5. Tough, large-weave plastic geogrids are used primarily for structural soil reinforcement. One important use in residential work is to tie together the soil mass of a segmental block retaining wall structure. Although the grids typically interlock with the individual block (above), they function mainly to lock the soil into a stable mass, not to tie back the block. With internal soil pressures managed by the geogrid reinforcement, segmental block walls can readily reach 30 feet or more in height (right).

to lock soils together into a strong, stable mass. They're often used as soil reinforcement under roads and behind segmental retaining walls (Figure 5, previous page).

Holes and ribs. Some geogrids are made by machinery that punches holes in a heavy sheet of polyethylene or polypropylene, then draws and stretches the material to create a framework of stiff ribs around openings 1 to 4 inches across. The stretching under controlled heat and pressure creates a strong plastic that can hold its shape under stress. Other companies use heavy plastic fibers to weave the grid pattern, and melt-bond or weave the intersections to create the screen structure.

But whatever the process, the products have similar engineering values. Their tensile strength and resistance to stretching give geogrids the ability to reinforce structural soils under roads, under foundations, and in earth walls. As with most geotech materials, the published values let the designer pick the material that's right for the job; but most applications require a qualified engineer.

Geonets are like geogrids, but their crisscrossing strands overlap to form an open weave that allows drainage along the plane of the material. Geonets are strong enough to provide reinforcement the way geogrids do, but in practice they're used almost entirely as sheet drainage materials, usually with filter-fabric facings to keep silt from clogging the weave. You won't see them much in building construction — their biggest use is to line landfills and collect leachate — but they do turn up as drainage elements under rooftop gardens or concrete decks over occupied space.

Geocells

The U.S. Army Corps of Engineers developed the first "cellular confinement system" for gravel and soil in the 1970s as a way to build roads over soft ground (Figure 6). The grids of deep, tube-shaped cells keep loose

Presto Products

Tenax

Terrafix

Figure 6. Cellular confinement systems, or geocells, lend great strength to roadbeds and embankments in heavy engineered applications. Gravel-filled Presto Geoweb geocell material provides a solid roadbed (top), while soil-filled Tenax Tenweb stabilizes a bank (above). Stacks of filled Terrafix Terraweb form a strong earth-retaining wall (left).

Figure 7. Some geocell materials are designed for light-duty applications. This porous grass parking installation (GrassPave from Invisible Structures) provides a stable surface that can stand up to car traffic but avoids the need for storm drains by letting rain percolate into the ground.

Invisible Structures

Figure 8. Geocomposite drainage systems, which combine a filter fabric with an open-weave web or dimpled sheet, provide high flow rates and quick installation. Some systems also provide waterproofing for foundations at the same time.

Cosella-Dörken

Figure 9. Besides fluid drainage, geocomposites can provide a vent for subsoil gases like radon, as in Colbond's EnkaVent system. A dense mat of stiff nylon filaments bonded to a polyester filter fabric is placed on the prepared subgrade before the slab is poured; if radon is detected later, vent piping can be connected to the sub-slab air space to vent the gas to the outdoors.

Colbond

material from spreading sideways, and spread vehicle loads over a wider area. In tests, heavy trucks made thousands of passes over a geocell roadbed with minimal rutting; without the system, the trucks quickly bogged down in the subgrade.

But roads aren't the only use of geogrids. Stacks of geogrids can also make a strong earth-retaining wall, which can be seeded with plants on its face. And for light parking use, soil-filled cells provide protection for turf, so that cars won't damage it (Figure 7).

Geocomposites

When you bond a layer of filter fabric to an open, free-draining component such as dimpled sheet plastic, drain tile, open-weave heavy geotextile, or geonet, you've got a geocomposite (Figure 8).

Eljen

Figure 10. Curtain drain systems can be more effective and quicker to build with geocomposite drainage components. Suppliers recommend a coarse sand backfill for filtration to prevent clogging of filter fabric. Flow rates can amount to hundreds of gallons a minute.

These products provide a quick solution for site or foundation drainage and reduce the need for granular fill. Some products provide only drainage, while others can waterproof a foundation and provide drainage in one step. There are even specialized geocomposites designed for efficient venting of radon and other gases (Figure 9, previous page).

But suppliers caution that if soils have heavy silt loading, the filters can become clogged. A soils engineer can provide appropriate details for specific site conditions; it's a good idea in general to provide some coarse sand backfill in contact with the geotextile filter element (Figure 10). This combination of a sand filter and a fabric filter can be counted on for indefinite service.

Resources

Suppliers

Amoco Fabrics and Fibers Co.
800/445-7732
www.geotextile.com

BBA Nonwovens-Reemay Inc.
800/284-2780
www.typargeotextiles.com

Belton Industries Inc.
800/225-4099
www.beltonindustries.com

Boom Environmental Products
800/770-2666
www.boomenviro.com

Carthage Mills
800/543-4430
www.carthagemills.com

Colbond Geosynthetics
The Netherlands
www.geosynthetics.colbond.com

Cosella-Dörken
888/433-5824
www.deltams.com

Drainage Products Inc.
860/668-5108
www.drainaway.com

Eljen Corporation
800/444-1359
www.eljen.com/index.html

Evergreen Technologies Inc.
800/984-9784
www.etigeo.com

Geo-Synthetics Inc.
800/444-5523
www.geosynthetics.com

Greenfix America
760/348-7600
www.greenfix.com

Huesker Inc.
800/942-9418
www.huesker.com/usa

Invisible Structures, Inc.
800/233-1510
www.invisiblestructures.com

Lun-Drain
800/948-5603
www.lun-drain.com

North American Green
800/772-2040
www.nagreen.com

Presto Products Co.
800/548-3424
www.prestogeo.com

Profile Products LLC
800/207-6457
www.profileproducts.com

SI Geosolutions
800/621-0444
www.fixsoil.com

SolPlast, S.A.
Spain
www.solplast.com (in Spanish)

Tenax Corp.
800/356-8495
www.tenax.net

Tensar Earth Technologies Inc.
800/836-7271
www.tensarcorp.com

Terrafix Geosynthetics Inc.
207/786-6808
www.terrafixgeo.com

WEBTEC Inc.
800/438-0027
www.webtecgeos.com

Western Excelsior Corp.
800/833-8573
www.westernexcelsior.com

For More Information

Geosynthetic Materials Association
800/225-4324
www.gmanow.com/

Geosynthetic Research Institute
215/895-2343
www.drexel.edu/GRI

Geosynthetica
561/265-0472
www.geosynthetica.net/

Industrial Fabrics Association International
800/225-4324
www.ifai.com