

TERRACELL[®]

CELLULAR CONFINEMENT SYSTEM



GROUND STABILIZATION

TerraCell is an innovative geosynthetic product made of high density polyethylene strips. These strips are ultrasonically welded to form an extremely strong, honeycomb configuration. A variety of fill materials may be placed within TerraCell: soil, sand, aggregate, concrete, etc. The TerraCell system and the appropriate fill material can solve a variety of engineering and construction challenges.



SLOPE PROTECTION



RETAINING WALLS

The function of the TERRACELL cellular confinement system in ground stabilization applications is to spread the loads imposed upon the system. It accomplishes this by confining the aggregate layer.

In many situations, TERRACELL makes it possible to use a reduced quantity of lower quality, locally available granular material. Benefits include savings in aggregate and improved long-term performance. TERRACELL can be used in a variety of stabilization projects including:

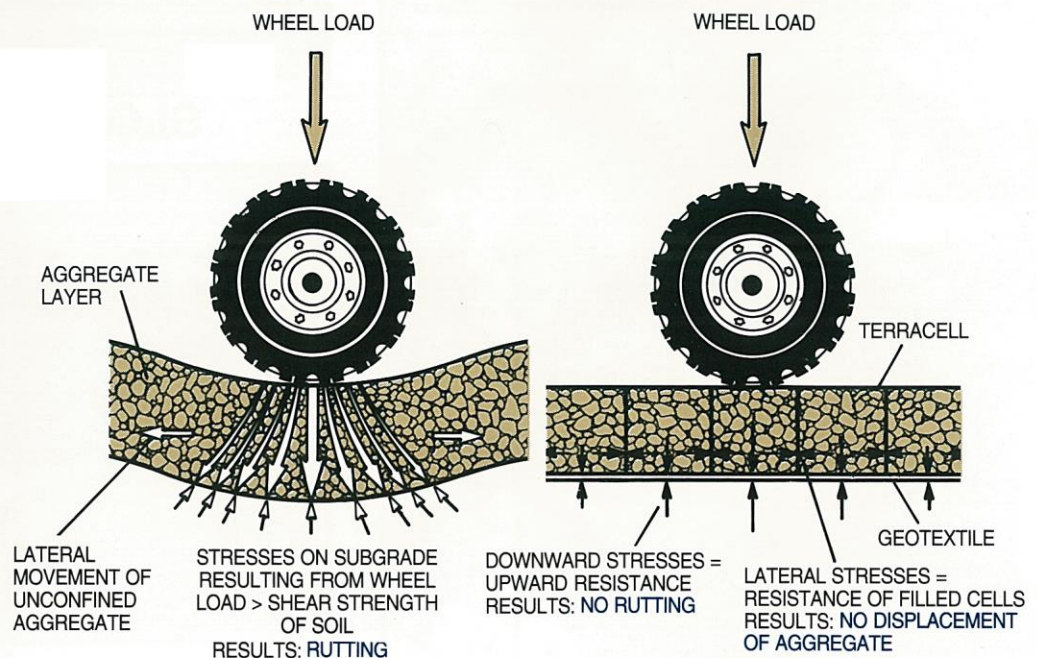
- STREETS, ROADS and HIGHWAYS
- PARKING LOTS, STORAGE AREAS and CONSTRUCTION ENTRANCES
- ACCESS LANES FOR FIRE / EMERGENCY VEHICLES
- RUNWAYS, TAXIWAYS, APRONS, and OVERRUN AREAS
- RAILROAD TRACK BEDS
- TEMPORARY ACCESS ROADS / LOGGING ROADS
- STREAM CROSSINGS / BOAT RAMPS
- WATER and SEWER LINES

Ground Stabilization

MECHANICS

In a ground stabilization application, the function of the aggregate layer is to spread the loads imposed on it so that the pressure, or force per unit area, exerted on the subgrade is reduced below a critical value. The aggregate layer transfers the load outward as well as downward and away from the source. Spreading of loads is accomplished by the interlocking and friction that occur between individual granular particles. The aggregate must be well compacted during construction and remain compacted and free from fines during the life of the project. In other words, for the aggregate layer to perform as designed throughout its intended life, the original quality and degree of compaction must be preserved.

Aggregate support systems are improved with the use of a geotextile fabric. Fabrics contribute to the long-term performance of aggregate layers because of their ability to separate and confine. Fabric acts as a permeable barrier between the aggregate and the subgrade, keeping the aggregate layer free from the fines that can destroy its load bearing characteristics. Fabric also provides a high friction surface that resists lateral movement by the lowest layer of aggregate, thereby confining those particles in direct contact with the fabric. Quality and state of compaction of the aggregate determine how well this layer can withstand lateral pressures above the lowest level.



HOW TERRACELL WORKS

The TERRACELL cellular confinement system provides confinement throughout the depth of the aggregate layer, not just at the interface between the aggregate and the subgrade. The ability of the aggregate layer to spread surface forces and reduce pressures on the

subgrade is no longer dependent solely upon the properties of the aggregate itself. TERRACELL provides the necessary confinement and preservation of compaction. This action allows the use of lower quality and/or quantity of more readily available aggregates

thus saving time and money. Studies and actual installations have shown that rounded aggregates, such as sand, confined within the cells, perform better than thicker layers of higher quality aggregates used without a cellular confinement system.

ECONOMICS

During construction of roads, parking lots, sewer lines, etc., pockets of soft, poor soils are sometimes encountered. Typically, soil is removed to a significant

depth and replaced with expensive fill materials. This procedure can be costly and time consuming. An effective alternative is to use a stabilization fabric with

TERRACELL placed directly on the prepared subgrade. Cells are then filled with readily available granular materials and compacted.

Refer to:
"TerraCell - Design Guidelines for Ground Stabilization"
on our website: www.WEBTECGEOS.com.

INSTALLATION

TERRACELL is installed quickly and easily by semi-skilled labor and without any special equipment. Sections are shipped to the job site in collapsed form.

1. A geotextile is often recommended to separate fill materials from the subgrade. Simply unroll the fabric directly onto the prepared subgrade, overlapping adjacent panels 12 to 24 inches.

2. Determine where the first section of TERRACELL is to be placed and put stakes at the four corners of the area.

Stakes can be wooden, metal (#3 or #4 rebar), or any suitable material that will not easily bend or break.

3. Overstretch the section of TERRACELL as much as

possible (beyond its proposed length) a few times and then place the four corners over the embedded stakes. Additional stakes may be needed along the perimeter in order to get full expansion of each section. In situations where it is difficult or impractical to use stakes to hold a section open, such as over an impervious liner, an installation frame may be used. Adjacent sections are installed in similar fashion and butted or stapled together to achieve continuous coverage.

4. Fill the first rows of cells with a front end loader or back-dump along the edge of the section and push the fill into the cells using a bulldozer blade. Continue until all

cells are filled. Never allow equipment to drive over unfilled cells. It is best to overfill slightly to allow for reduction in volume of the granular material as it is compacted.

5. Compact the fill material. Depending on the nature of the aggregate, a vibratory roller and/or water may be required to achieve a desired compaction level. The most common method of compacting the aggregate is through multiple passes by tracked equipment.

Once the cells are filled and the aggregate compacted, the TERRACELL constructed base is ready to withstand heavy traffic loads.

The function of
TERRACELL
cellular confinement
system is:

(A) **EROSION CONTROL**—to minimize and/or eliminate the erosive actions of wind and water on exposed soils.

(B) **SLOPE STABILITY**—to prevent sliding or sloughing off by providing sufficient weight at the foot and/or along the face of the slope.

Benefits include cost savings in materials and labor during both installation and subsequent periodic maintenance. TERRACELL can be used in a variety of erosion control or slope protection projects, including:

- SLOPES and CUTS
- SHORELINES
- RIVER BANKS
- CHANNEL BANKS and LININGS
- CULVERT and SEWER PIPE OUTFLOWS

Slope Protection

MECHANICS

(A) **EROSION CONTROL**: Most unprotected soil surfaces are prone to erosion. It takes place when the forces of the wind or flowing water dislodge and transport soil particles. Although silty soils are most susceptible to erosion, clays and sands are at risk when strong erosive forces exist. Erosion occurs when flowing water or heavy winds form rills in the soil. Over time, these forces are concentrated within the rills. This accelerates the erosive process and makes the rills deeper. For a storm of a given duration and intensity, three principal site parameters determine the amount of erosion likely to take place:

1. steepness of the slope
2. height and length of the slope
3. type of soil on the surface of the slope

On short and gentle slopes, seeding that is protected by excelsior/straw blankets or an erosion control fabric is usually the most cost-effective method of erosion protection. In more severe erosive situations, a geotextile and a layer of stone 12 to 24 inches deep might be required on the face of the slope. Although this arrangement can be effective in preventing erosion, in comparison to the TERRACELL system, it tends to be very costly and highly unattractive. Drawbacks include creating an environment for rodents and insects by allowing vegetation to grow where it is difficult to cut and control. This creates a potential hazard for children and animals.

(B) **SLOPE STABILITY**: For any given soil at a certain moisture content, there is an angle beyond which the soil will not stand without external support. Whenever the steepness of the slope exceeds this failure angle, gravitational forces act on the soil mass to create shear stresses causing the slope to fail through sliding or sloughing off. The process ends when a new equilibrium is achieved at an angle less steep than the initial one.

In many situations, it is desirable to have a slope steeper than the shear strength of the soil will allow. One method employed to achieve this objective is to provide external weight at the foot and/or along the face of the slope. The resulting counterweight increases the effective failure angle, preserving the stability of the slope. Riprap is commonly used because of its weight and the fact that it also acts as an erosion control material. As discussed previously, riprap has serious drawbacks.

Refer to:
"TerraCell - Design Guidelines for Slope Erosion Control"
on our website: www.WEBTECGEOS.com.

HOW TERRACELL WORKS

For difficult erosion control situations, the TERRACELL cellular confinement system can be substituted for a more conventional "hard" system of expensive, heavy materials such as riprap, armor stone, revetment mats, gabions, etc., depending upon the severity of the erosive forces encountered. TERRACELL can be filled with soil or sand, small rock, concrete, etc. The cells confine the fill material and protect it from being moved by wind or water. Each cell in the system acts as a small dam that allows water or wind to pass over the top while holding the fill in place. The cell walls inhibit formation of rills, thus preventing the erosion process from developing. Lastly, a soil-filled TERRACELL slope can be seeded without worry that the system will interfere with mowing operations.

In areas subjected to substantial erosive forces such as shorelines, bends along river banks, outflow pipes, etc., concrete might be the most effective material selected to prevent erosion. When filled with concrete, TERRACELL becomes an articulated concrete mat that conforms to possible differential settlement while protecting the underlying soil from either wind or water erosion.

ECONOMICS

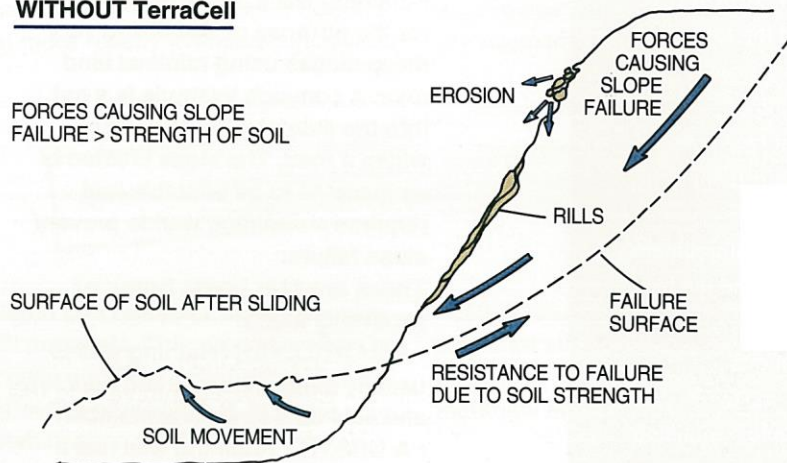
Slope protection using heavy armor stone tends to be very costly in terms of materials and the time consumed in installation, especially if the rock must be transported from

In slope stability situations, where external weight on the slope is needed to achieve stability, TERRACELL keeps the fill material in place so that its function as a

counterweight is preserved. TERRACELL (8") filled with sand provides an evenly distributed weight of approximately 80 pounds per square foot.

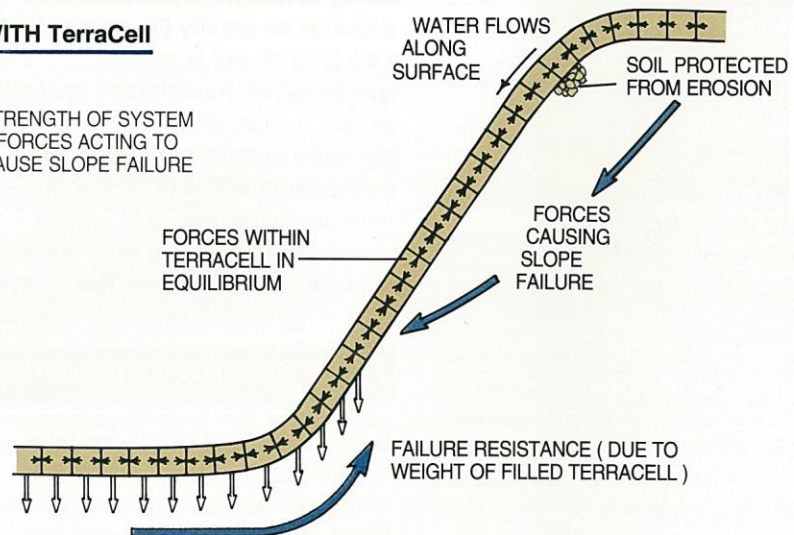
WITHOUT TerraCell

FORCES CAUSING SLOPE FAILURE > STRENGTH OF SOIL



WITH TerraCell

STRENGTH OF SYSTEM > FORCES ACTING TO CAUSE SLOPE FAILURE



INSTALLATION

TERRACELL used in erosion control and slope protection applications is installed in the same manner as in ground stabilization projects. (Additionally, stakes should be left in place to insure

that TERRACELL will remain permanently anchored to subgrade). When using concrete, place the concrete as in any other form, exercising care not to cause the TERRACELL to be displaced

during the pouring operation. Whether using fill materials or concrete, it is recommended that the cells be filled from the base of the slope upward.

The TERRACELL cellular confinement system acts as a form for containing the granular materials used to build the structure and provides tensile reinforcement. TERRACELL accomplishes the following:

1. prevents possible erosion and allows compaction of face materials without causing them to be dislodged.
2. provides reinforcement of materials behind the face.

In many situations, TERRACELL makes it possible to build a retaining wall using locally available soils and/or aggregates. In some cases, a combination of the two types of materials is both practical and cost effective. The locally available soil, including material not of the quality normally specified for use in constructing retaining walls, is placed in the cells. A free-draining material would be placed behind and below the TERRACELL to alleviate any potential hydrostatic problems developing at the back of the wall. TERRACELL can also be used in a variety of other vertical or near vertical structures, including:

- BULKHEADS
- RIVER BANK/CHANNEL WALLS
- DIKES & COFFERDAMS

Retaining Walls

MECHANICS

Retaining walls are structures built for the purpose of stabilizing very steep slopes using minimal land area. A common example is a cut into the side of a hill to build or widen a road. The slope created is so steep as to be unstable and requires a retaining wall to prevent slope failure.

There are two basic types of retaining walls:

- A **CANTILEVER** retaining wall is usually made of reinforced concrete and acts as a structural member.
- A **GRAVITY** retaining wall has a vertical or near vertical face and its ability to retain the soil behind it depends on gravity (its own weight). This type of wall is usually composed of unreinforced concrete or soil. If made of soil, the wall generally consists of a facia and one or more layers of reinforcing member (geotextile, grid, metal strips, etc.) extending from the facia back into the soil mass. The

functions of the facia are to prevent soil from sloughing off the surface of the wall and to prevent erosion of the face of the wall. The function of the reinforcing member is to increase the effective thickness of the wall which increases its stability.

The wall itself must be built to withstand pressures applied by the retained soil. This force, "lateral earth pressure", is dependent upon several parameters, including the geometry of the wall and the characteristics of the retained soil, such as its unit weight and angle of internal friction. In designing a retaining wall, it is necessary to consider potential forces that could cause wall failure and compare them to the stability calculations of the proposed wall, taking into account generally accepted safety factors.

HOW TERRACELL WORKS

When the TERRACELL cellular confinement system is used to construct a retaining wall it functions as both the facia and the reinforcing element. A section of standard dimensions filled with soil or rock acts as a large heavy mattress. These mattresses are the building blocks for a gravity retaining wall. The mattresses can be placed with either dimension along the face of the wall creating a structure with inherent stable characteristics. TERRACELL keeps the soil or rock from falling or being eroded off the face of the wall. Its confining action prevents dislodging of the fill at or near the face during compaction. Lastly, the size of

expanded TERRACELL panels significantly increases the effective thickness of a wall. This allows walls of considerable height to be built without the need for additional reinforcing elements, such as grids or metal tie-backs.

Although TERRACELL can make the building of retaining walls simple and straightforward, the design of these structures is crucial to their successful performance. Considerations, such as internal and external drainage in critical portions of the wall, must be addressed. Plans for any vertical structure should always be prepared by an experienced designer.

ECONOMICS

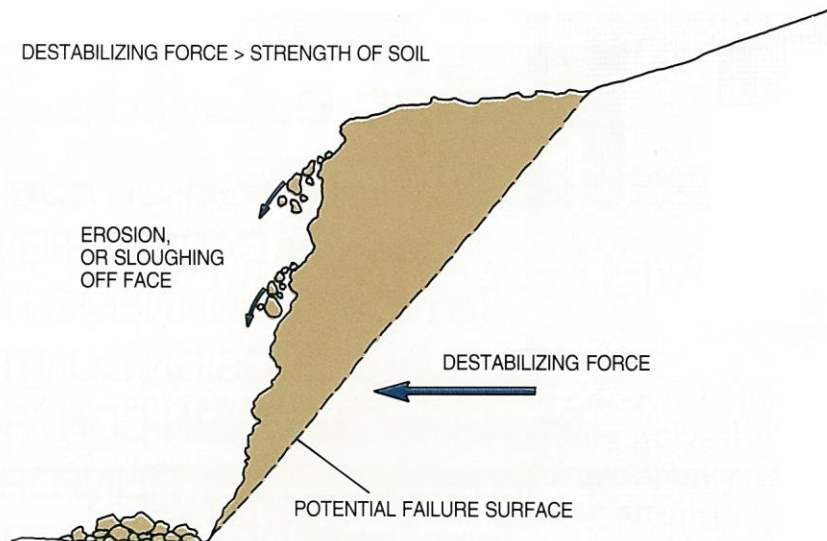
A poured-in-place concrete wall or a wall composed of costly materials such as select fills, timbers, steel, concrete block, or gabion baskets, can be very expensive and time consuming to construct. A gravity retaining wall made of TERRACELL and locally available soils and/or aggregates offers an economic alternative to these other systems.

INSTALLATION

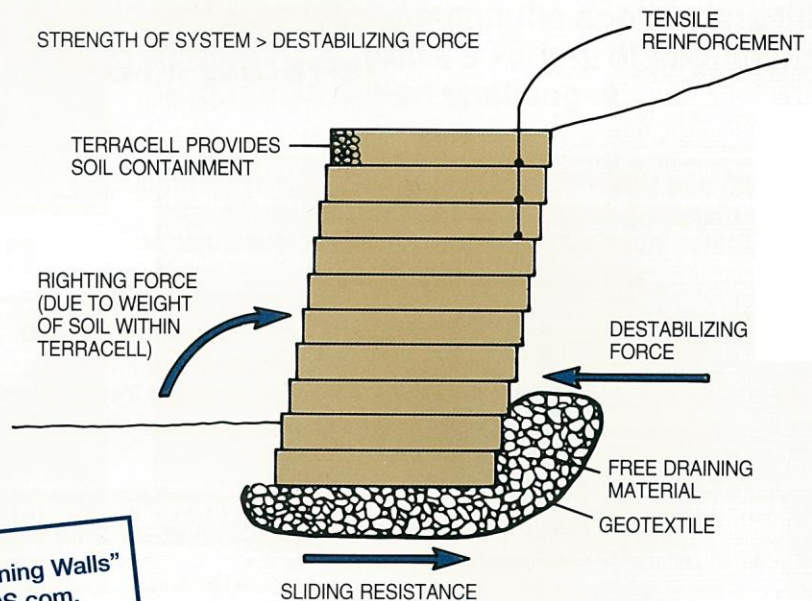
Install the bottom section of TERRACELL in much the same manner as described in the stabilization section. In most applications, place the second and subsequent sections such that the front of each panel is slightly offset back from the front of the panel below. Also, stagger the sections in brick laying fashion so that the panels are not directly on top of each other. As the wall increases in height, keep heavy compaction equipment off the face and sides. As always, observe all safety precautions. Insure that any internal or external drainage materials or procedures required are properly installed.

Refer to:
"TerraCell - Design Guidelines for Retaining Walls"
on our website: www.WEBTECGEOS.com.

DESTABILIZING FORCE > STRENGTH OF SOIL



STRENGTH OF SYSTEM > DESTABILIZING FORCE



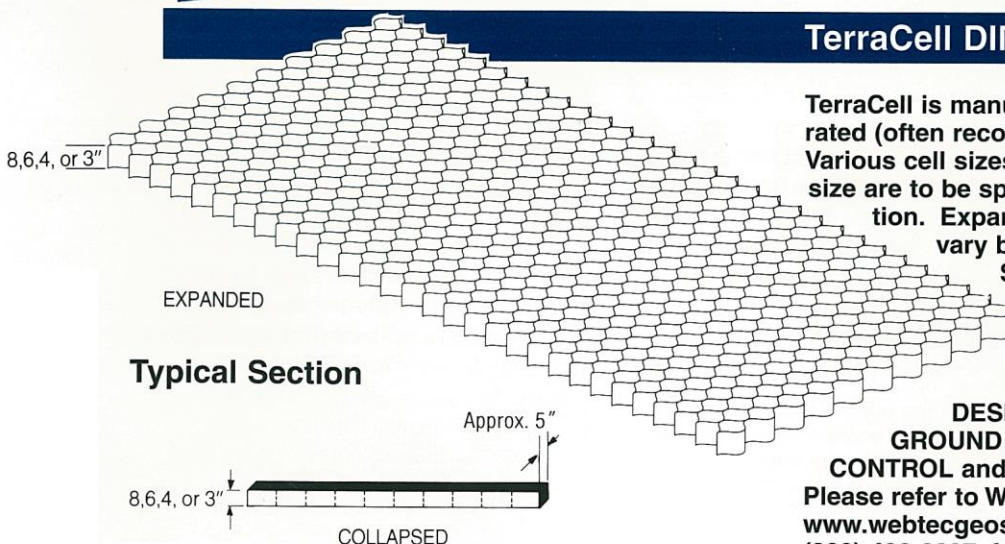
TerraCell DIMENSIONS

TerraCell is manufactured in several heights in perforated (often recommended) or solid wall versions. Various cell sizes are available. Cell height and cell size are to be specified based on the project application. Expanded TerraCell section dimensions vary by cell size and number of strips used. Sections can often be under-expanded or over-expanded to meet coverage requirements. Refer to TerraCell specifications for details.

DESIGN GUIDELINES are available for GROUND STABILIZATION, SLOPE EROSION CONTROL and RETAINING WALL applications. Please refer to WEBTEC's website, www.webtecgeos.com, or call us toll-free, (800) 438-0027, for this or any other information.

EXPANDED

Typical Section



HANES Geosynthetics Include:

TerraTex CONSTRUCTION FABRICS®
TerraTex BARRIER FENCING™
TerraCell® CONFINEMENT SYSTEM
TerraJute™ EROSION CONTROL FABRIC
TerraGuard™ EROSION CONTROL BLANKETS
TerraGuard™ TURF REINFORCING MATS
TerraDrain® DRAINAGE COMPOSITES
EconoFence® SILT FENCES
TerraGrid® GEOGRIDS
TerraTex FILTERBAGS™

TerraCell® and Hanes' broad line of geosynthetic products are marketed through a network of local distributors. For further information, contact your local distributor or:



Corporate Member



International Erosion Control Association



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