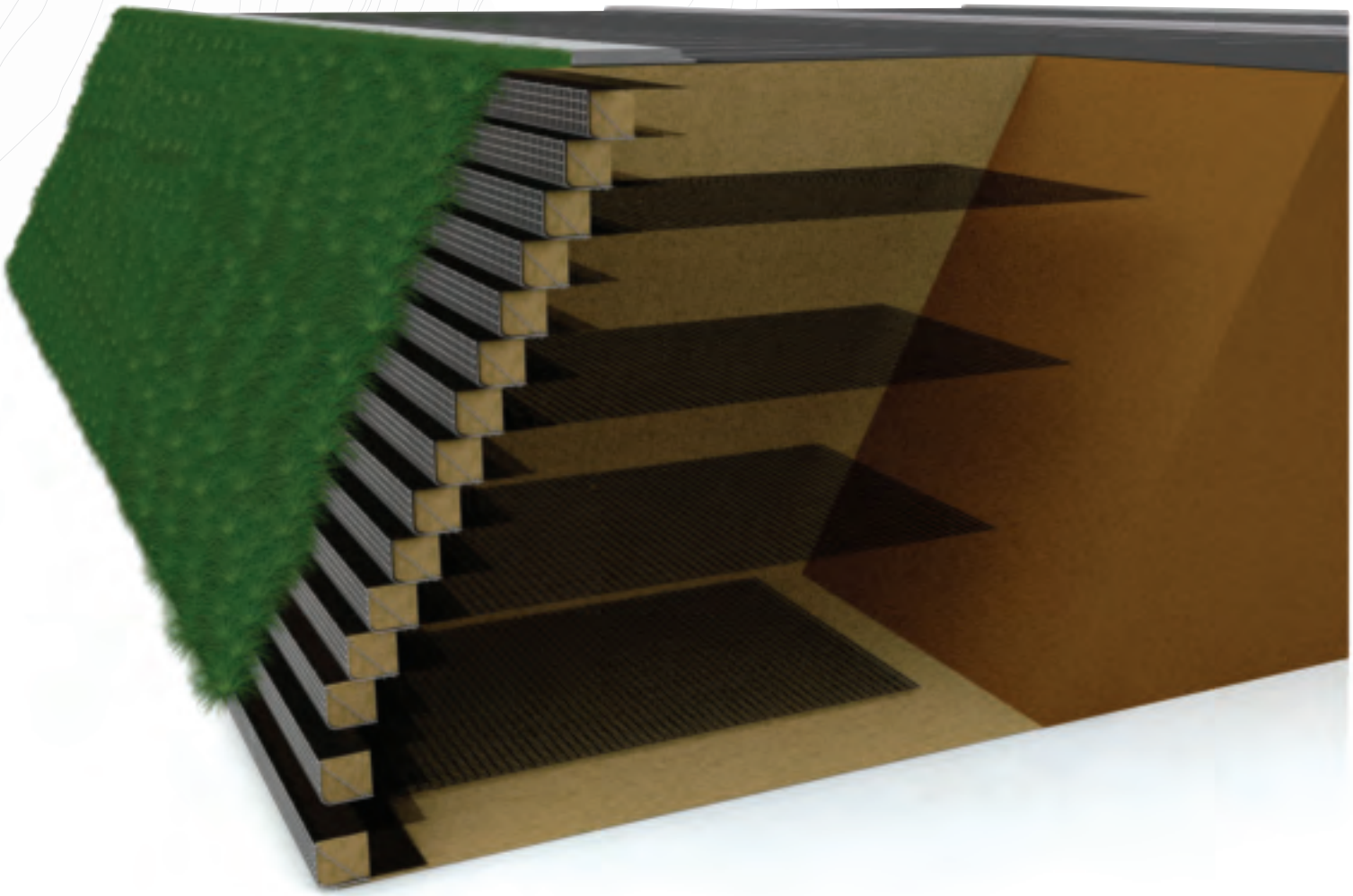
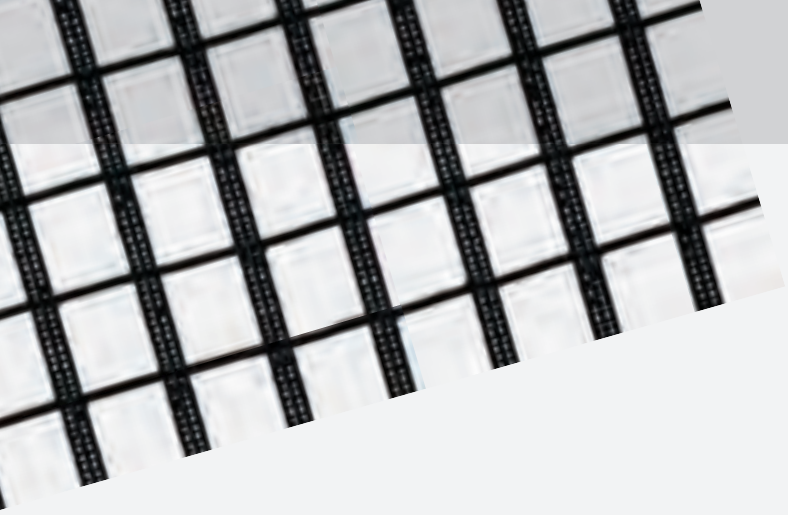
# Strata Soil Reinforcement
# Solutions for Slopes and Walls

Confidence runs deep with Strata.

STRATA
Global GeoSolutions





**Nature has its limits when it comes to resolving site development problems and maximizing land use. Grade change issues can determine the overall feasibility of a project. Mechanically stabilized earth (MSE) allows civil engineers to stabilize soils at steeper angles, affording the most flexible and cost effective change-in-grade construction solution available. Strata's mechanically stabilized earth systems include retaining walls, reinforced steep slopes, temporary walls and embankments.**

Strata Systems, Inc. is a manufacturer of advanced soil reinforcement products with global distribution and technical resources to meet the challenging and changing dynamics of any site development including highway, municipal, commercial and residential projects. Strata provides innovative systems and technology that provide economic advantages while ensuring structural integrity and sound engineering principles.

**Maximizing Land Use** Strata recognizes that maximizing land use is the most critical need and major cost impact on any site development. Challenges in resolving grade change on the site are increasingly necessary as land cost increases and the difficulty to develop property becomes commonplace. As illustrated on page 4, the incorporation of Strata products or systems provides for maximum land use. This ensures the owner full utilization of the developed site with long-term structural performance for the engineer at a cost structure beneficial to all.

**Strata Solutions** The StrataSlope, Strata Wall and Strata Embankment systems provide the technical basis and economic solution to severe topographic challenges, problematic soil conditions, and land development needs. The Strata "systems" incorporate high quality, knitted geogrid materials with various face treatments that address long-term structural stability, erosion, and aesthetics. Incorporation of indigenous and more weather or erosion tolerant vegetative species and hard armoring such as concrete SRW units or crushed stone provide a multitude of engineering and aesthetic solutions.

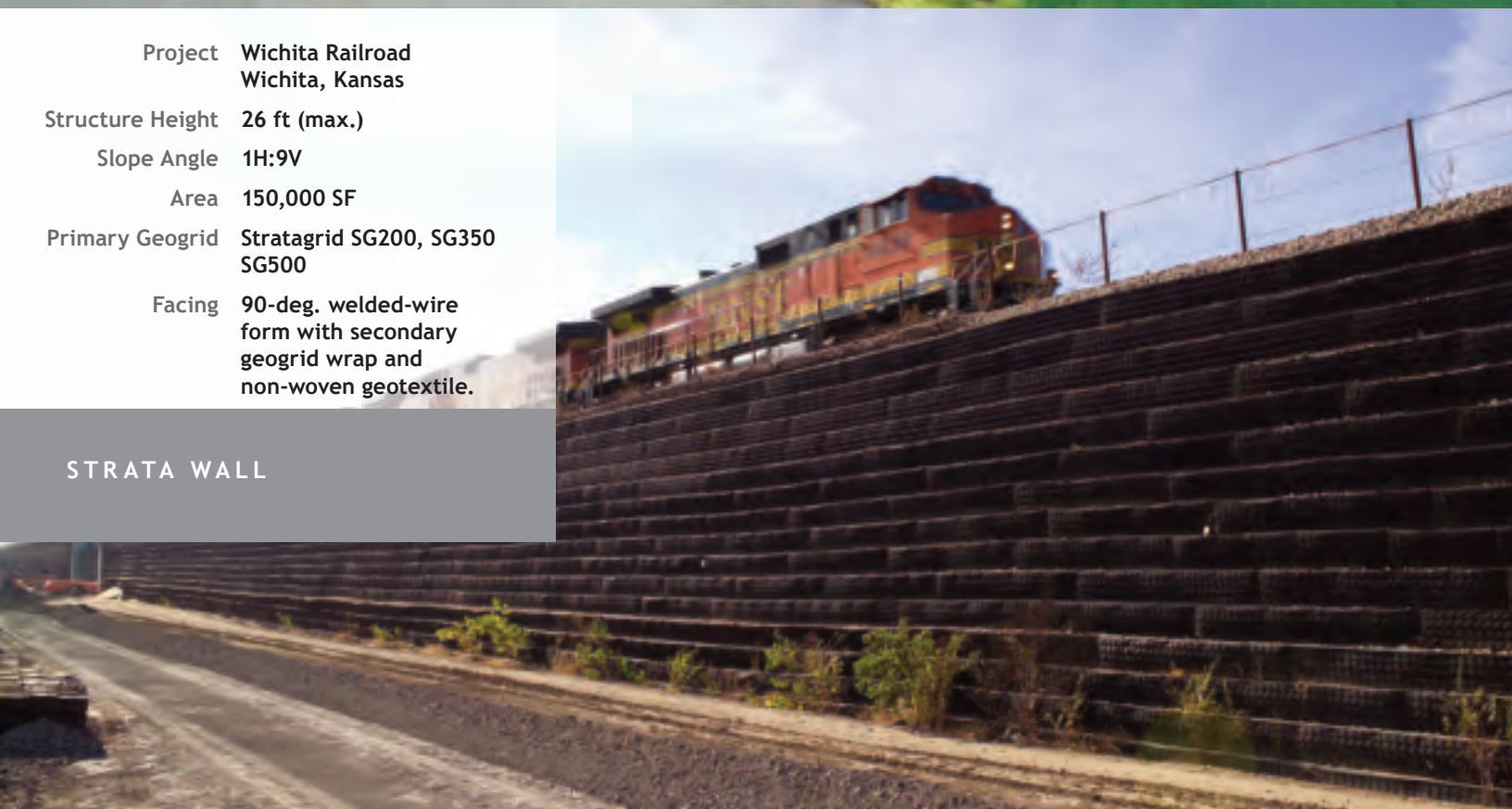
**Exceptional Performance** The Strata solution ensures the highest levels of quality. Strata strives to provide the best in customer satisfaction and works closely with the developers, engineers and customers for the most cost effective designs. Custom manufacturing capabilities, including product roll widths up to 18-ft (5.5m) and variable roll lengths, coupled with nationwide and international distribution make Strata the optimum choice for any site

| | |
|---|---|
| Project | Norwich Technical H.S.<br>Norwich, Connecticut |
| Structure Height | 15 ft (max.) |
| Slope Angle | 1H:3V |
| Area | 6,400 SF |
| Primary Geogrid | Stratagrid SG200, SG350 |
| Facing | 90-deg. welded-wire form with Microgrid face wrap and pre-seeded top soil behind wire form |

## STRATASLOPE

| | |
|---|---|
| Project | Wichita Railroad<br>Wichita, Kansas |
| Structure Height | 26 ft (max.) |
| Slope Angle | 1H:9V |
| Area | 150,000 SF |
| Primary Geogrid | Stratagrid SG200, SG350<br>SG500 |
| Facing | 90-deg. welded-wire form with secondary geogrid wrap and non-woven geotextile. |

## STRATA WALL



# Strata's Mechanically Stabilized Systems

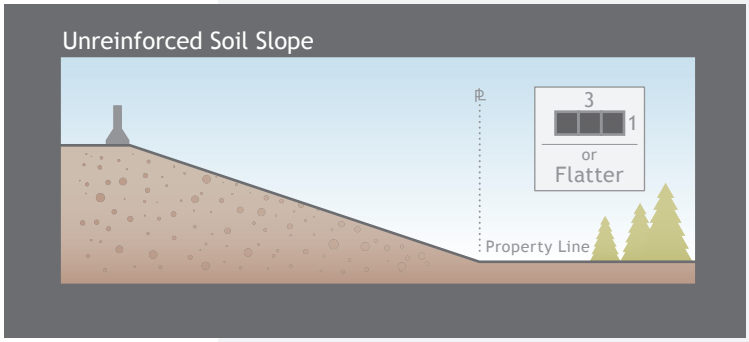
**Design Benefits** The Strata solution considers state-of-the art product manufacturing and systems development while addressing fundamental engineering principles based upon traditional geo-mechanics and polymeric reinforcement design. Strata "systems" are classified as geosynthetic reinforced soil structures, a subset of mechanically stabilized earth (MSE) systems. These systems use recognized technology that has been evaluated and accepted by major agencies, including the Federal Highway Administration, US Army Corps of Engineers, and other state and government agencies as well as international acceptance. MSE systems are simply defined as soil structures comprised of multiple layers of inclusions (geogrid) that act as reinforcement in soil placed fill. MSE structures are categorized into two major groups:

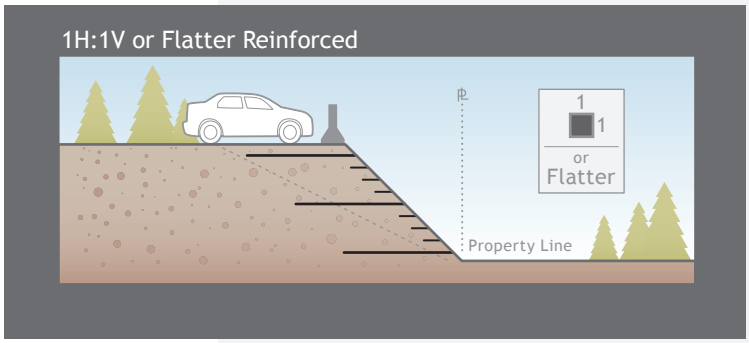
1.) Slopes – structures in which the face is ≤ 70° from horizontal

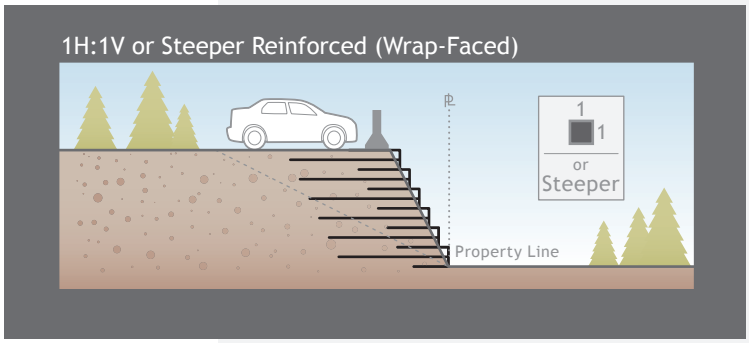
2.) Walls – structure in which the face is > 70° from horizontal

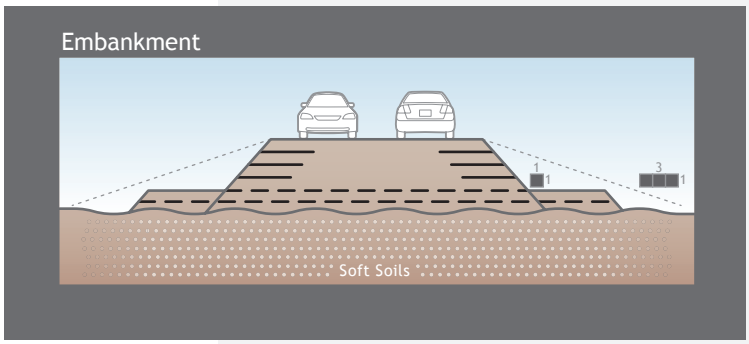
Embankments represent a special class of slopes or walls where soil reinforcement is used to stabilize and construct a fill structure having a smaller footprint than what could be constructed with the soil alone. Embankment stabilization is common when constructing roadways or other structures over soft, weak foundation materials.

MSE structures are designed using accepted guidelines that address the unique structural requirements for each configuration, wall or slope. Walls are commonly designed using Rankine or Coulomb earth pressure theory to predict design reinforcement loads and overall reinforced soil geometry. Slopes and embankments commonly utilize limit equilibrium methods such as Bishop's Method of Slices to evaluate structural stability. Limit equilibrium methods are also utilized to evaluate the overall/global stability of retaining walls. Regardless of the design method, Strata products can be designed and installed to meet the challenge.



# Facing Options

Several key factors that influence face selection are final face/structure batter and capacity to support vegetation. In regions where sufficient rainfall or irrigation is possible, vegetation offers the most economical facing choice. Vegetated slopes have many benefits – provide opportunity to utilize indigenous species or select species more tolerant to variations in weather, provide a green aesthetic that softens hard architectural features, provide visual relief for structures subject to settlement, and minimize requirements for select aggregate. Vegetated structures may be constructed to near vertical geometry; however, the more vertical the structure, the more critical irrigation and plant selection.

For conditions where the slope is 1H:1V or flatter, primary and secondary geogrids are combined with traditional erosion protection products and vegetation to provide a sound engineered solution.

Temporary forms or welded-wire forms are commonly utilized with Microgrid face wrap and primary geogrid for structures steeper than 1H:1V. In this situation, the welded-wire form functions solely as a construction form, and the Microgrid face wrap combined with permanent vegetative cover provide the long-term facing stability. Primary geogrid addresses the overall structural stability of the slope.

In arid regions or situations where structure batter is prohibitive to supporting vegetation, a rock or crushed-stone facing is recommended. Galvanized (often hot-dipped) welded-wire forms are used to provide a long-term facing that also functions as the construction form. Rock selection is based on aesthetics and geometric opening size of the wire form. Strata can provide wire forms

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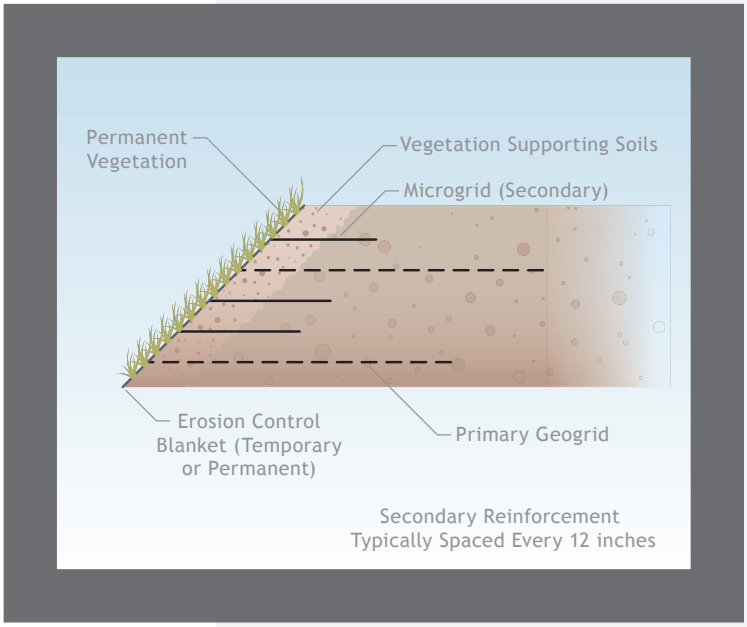
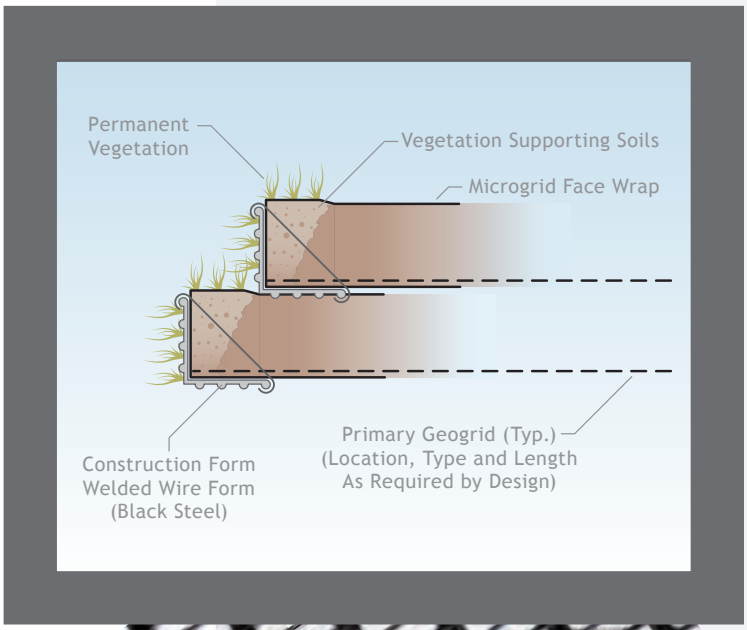
*1H:1V or Flatter - Vegetated*




*1H:1V or Steeper - Vegetated*



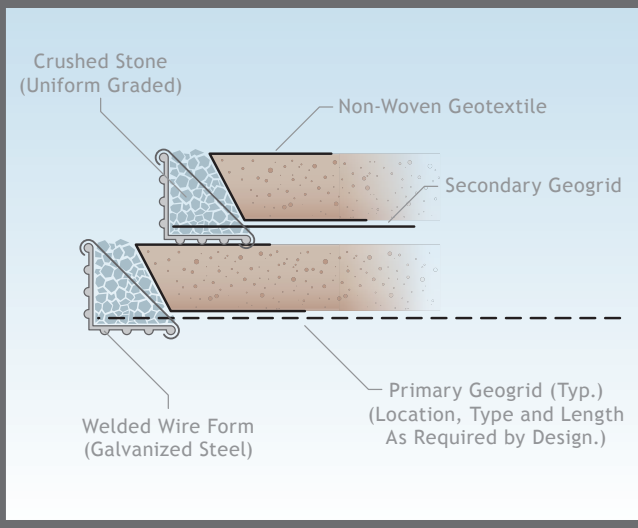

modified apertures such as 2” x 12” openings to accomidate the use of smaller aggregate. Stone facing is commonly utilized for permanent structures with near vertical geometry or waterway applications where water elevations prevent the establishment of vegetation.

Woven and non-woven geotextiles are often utilized as the face wrap for temporary structures. Conventional black steel, welded-wire forms are utilized simply as construction forms for temporary applications. Temporary applications include roadway re-alignments, surcharge embankments, and staged construction.

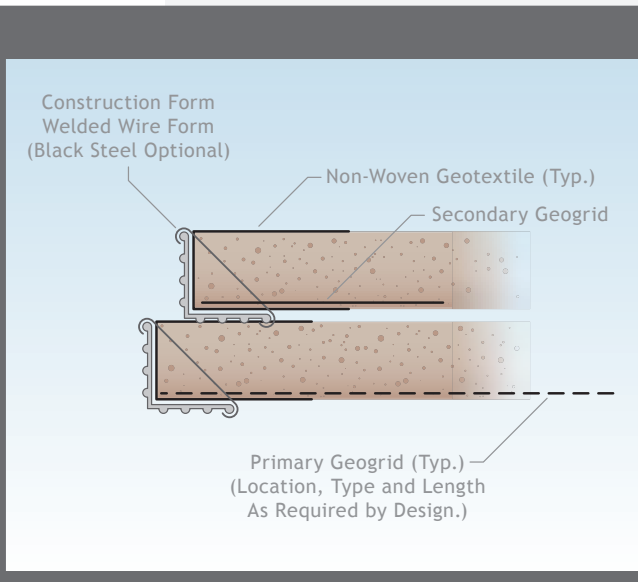
## Advantages

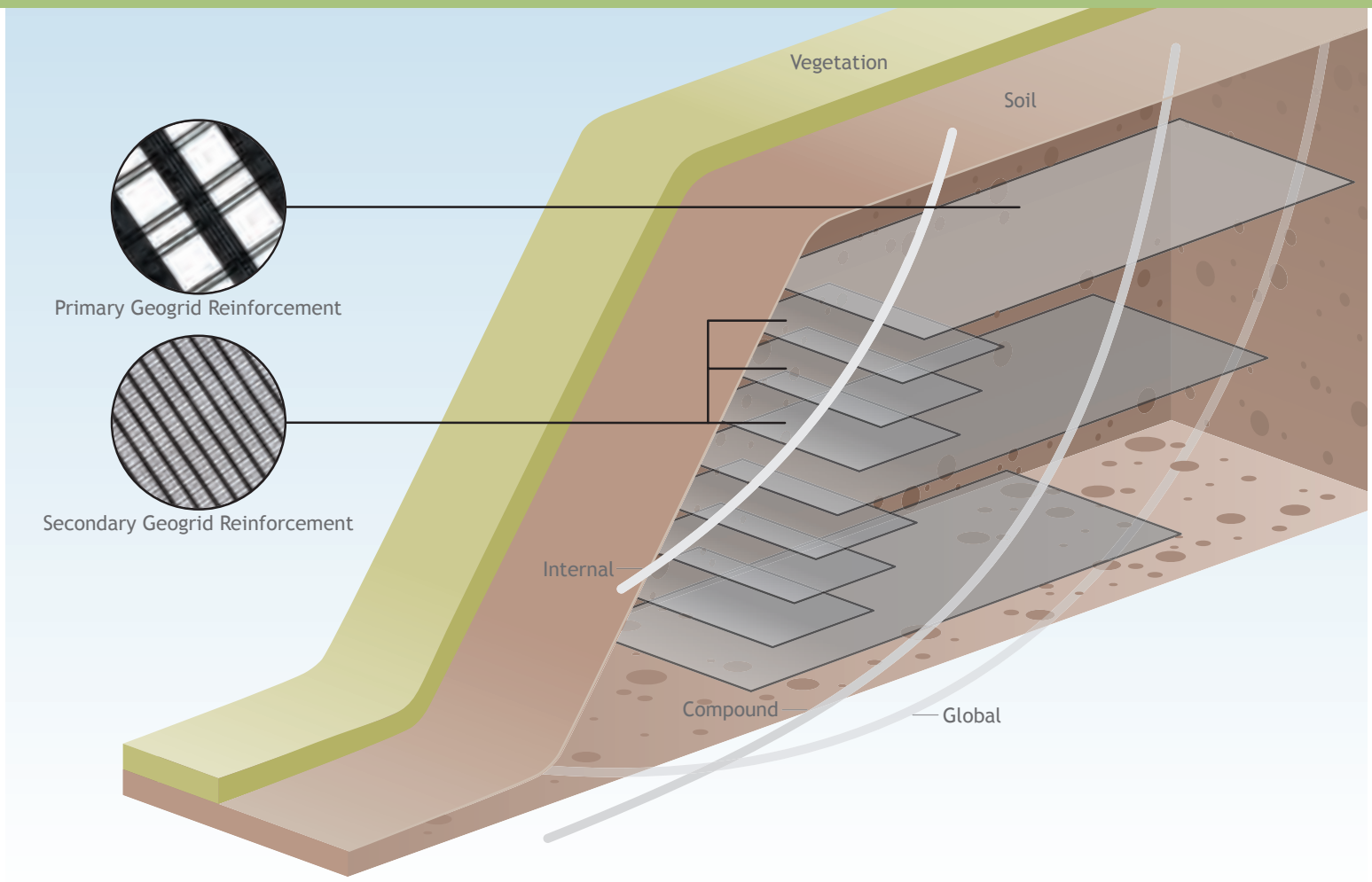
- **Significant cost savings compared to steel-reinforced concrete structures**
- **Tolerant of total or differential settlement**
- **Multiple facing solutions including vegetation and rock fill**
- **Fast Installation (1,000 to 1,500 sf/day)**
- **Environmentally friendly - ‘Green’ solution**
- **Minimize impact on environmental areas (i.e. wetlands, natural habitats)**
- **Excellent structural capacity (i.e. 70° reinforced slopes exceeding 90-ft vertical height)**
- **Utilize on-site fill or minimize borrow requirements**

*1H:1V or Steeper - Stone Facing*




*Temporary Structures*






## Slope Stability

Slope stability design is commonly evaluated using limit equilibrium methods such as Bishop's Method of Slices. The approach is to calculate the driving and resisting forces along a circular (or log-spiral) slip surface and determine the factor of safety against rotation or movement. The location of the slip surface (circular or log-spiral) is commonly utilized to define three failure regimes:

**1.) Internal – failure surfaces that are contained entirely within the reinforced soil zone**

**2.) Compound – failure surfaces that begin outside or behind the reinforce soil zone but pass through the reinforcement and exit in the foundation or through the structure face**

**3.) Global – overall/deep seated failure surfaces that pass outside the reinforcement and into the underlying foundation soils**

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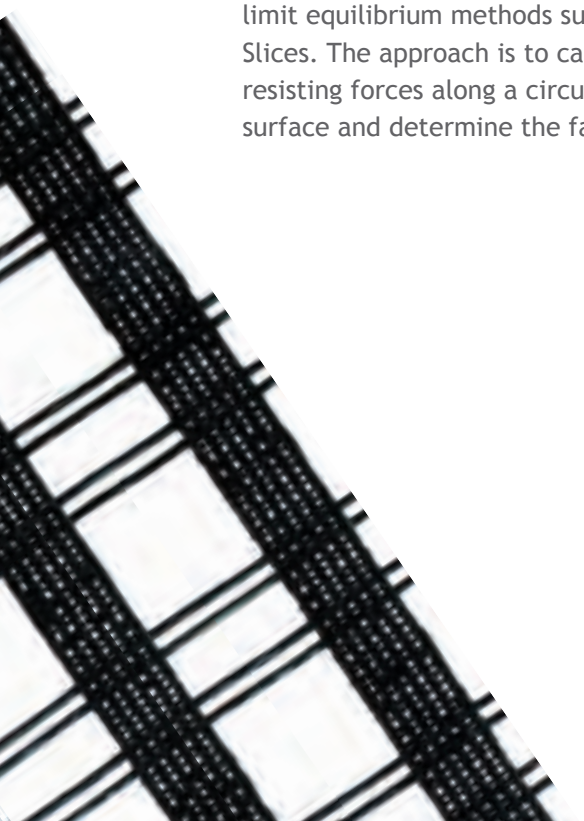


| | |
|---|---|
| Project | **Donzi Landfill Atlanta, Georgia** |
| Structure Height | **26 ft (max.)** |
| Slope Angle | **1H:2V; 1H:1V** |
| Area | **120,000 SF** |
| Primary Geogrid | **Stratagrid SG500, SG550** |
| Facing | **90-deg. welded-wire form with secondary geogrid wrap and gravel fill** |

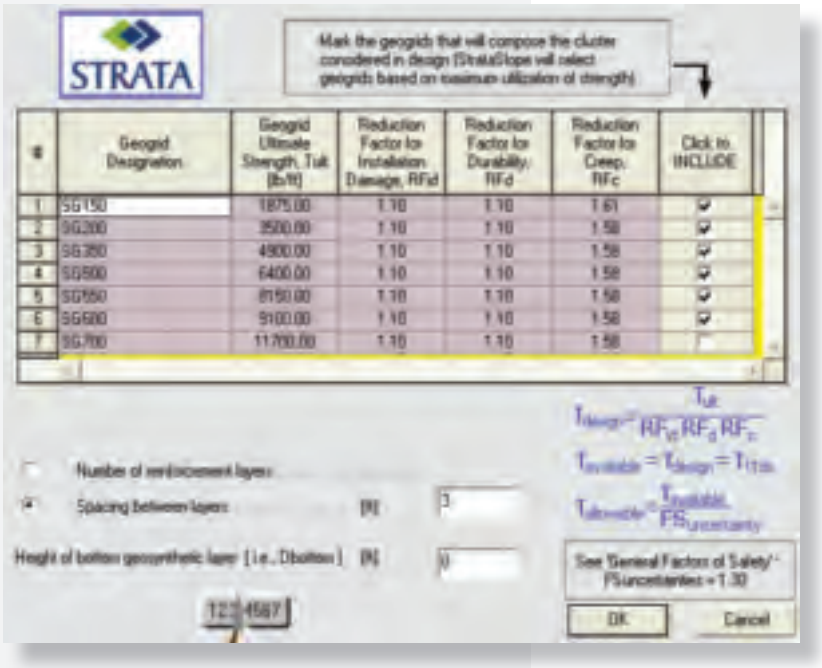
## STRATASLOPE

Regardless of the failure regime, the designer must analyze numerous failure surfaces and isolate that surface which generates the least factor of safety for stability.

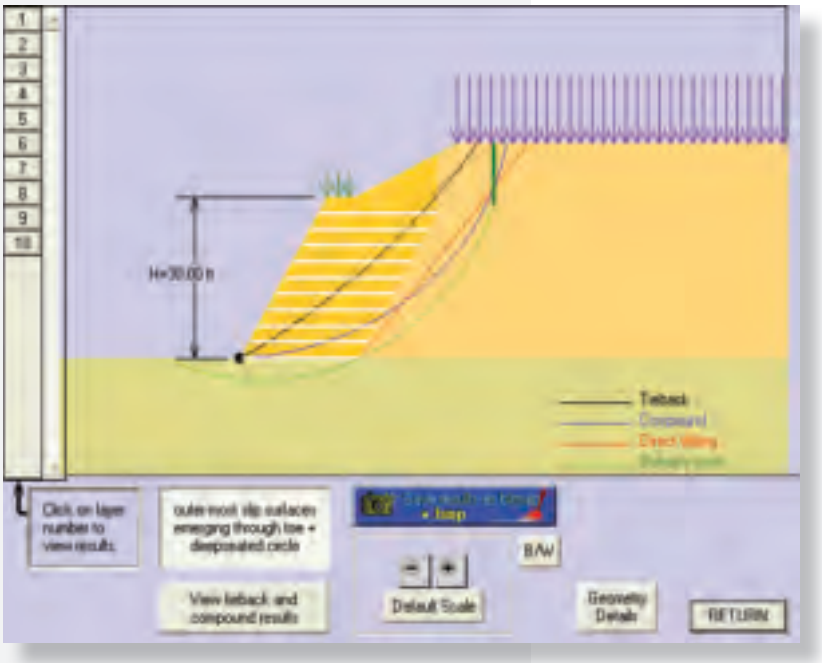
Computer software allows the designer to rapidly analyze thousands of failure surfaces and optimize reinforcement requirements to provide adequate factors of safety at the best economics. For each failure surface passing through a layer of reinforcement, the analysis considers the tensile strength of the reinforcement to investigate tensile rupture or failure, and geogrid pullout resistance.

Strata makes available to the designer tools that allow easy selection of primary and secondary reinforcements. StrataSlope Software is a limit-equilibrium design package that automates primary geogrid reinforcement design utilizing circular or log-spiral failure surfaces with the Bishop's Method of Slices. Additional tools are available that address surficial stability using parallel failure surface of infinite length (i.e. sliding wedge approach).

*Limit Equilibrium*




*Graphic Results*




# Strata Slope Software

StrataSlope is an interactive, design-oriented, program for reinforced slopes and walls using Stratagrid reinforcement layout (i.e. length, spacing and type) while taking into account appropriate geosynthetic material properties, reduction factors and design safety factors. The software considers tie-back and compound stability using log-spiral failure surfaces, direct-sliding using conventional two-part wedge mechanism, and deep-seated stability analysis using Bishop's method.

Optimized for the design of reinforced slopes and walls, the software accommodates complex geometries with up to three different soil zones (reinforced, retained and foundation), as well as inclined toe and top slopes, up to three uniform surcharge areas, and offers the options to include pore water pressure and seismic stability. StrataSlope can conform to US or international design standards (BS 8006).

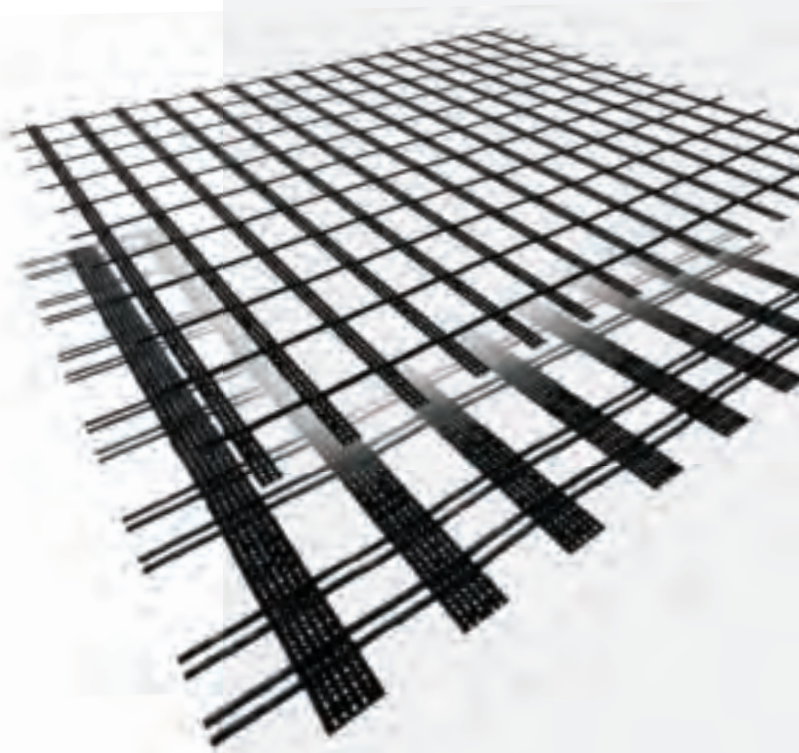
## Advantages

- **Provides quick analysis of reinforced slope structures**
- **Valuable tool for material estimating**
- **Considers limit equilibrium using Bishop's Method of Slices**
- **Evaluates internal stability (tie-back and compound) based on log-spiral surfaces**
- **Addresses direct sliding stability using 2-part wedge method**
- **Directly integrates Strata Soil Reinforcement products**

## Additional tools available

- **Reinforced soil slope manual**
- **Facing / surficial stability design tools**
- **CADD details for reinforced slopes and segmental retaining walls**

STRATA



StrataWall and StrataSlope systems provide designers and engineers with an array of options for building retaining walls, vegetated steep slopes, temporary walls, and embankments. Not only are Strata products easy to handle and simple to install, they're built to last.

But Strata doesn't just manufacture the industry's highest quality geogrid products. Our dedicated engineering staff adds value to each soil reinforced system with a comprehensive program of world-class technical support. Strata's superior customer service begins with the design and bidding process, continues through ongoing consultations, and extends to expert installation training and other on-site assistance.

Sleeve-It™, Strata's code-compliant system specifically designed for integrating fence and pedestrian rail post anchors into retaining walls as they're built, is just the latest example of Strata product ingenuity, strengthening Strata's commitment to developing innovative system solutions that are as reliable as they are affordable.

## *Stratagrid*®

**The industry's first geogrid material knitted from high molecular weight and high tenacity polyester yarn. Engineered strength to comply with your geogrid application no matter how big the job.**

## *Microgrid*™

**A small aperture geosynthetic specially developed for face wrap applications**

## *StrataTex*

**WOVEN**

**Geotextiles for separation and reinforcement**

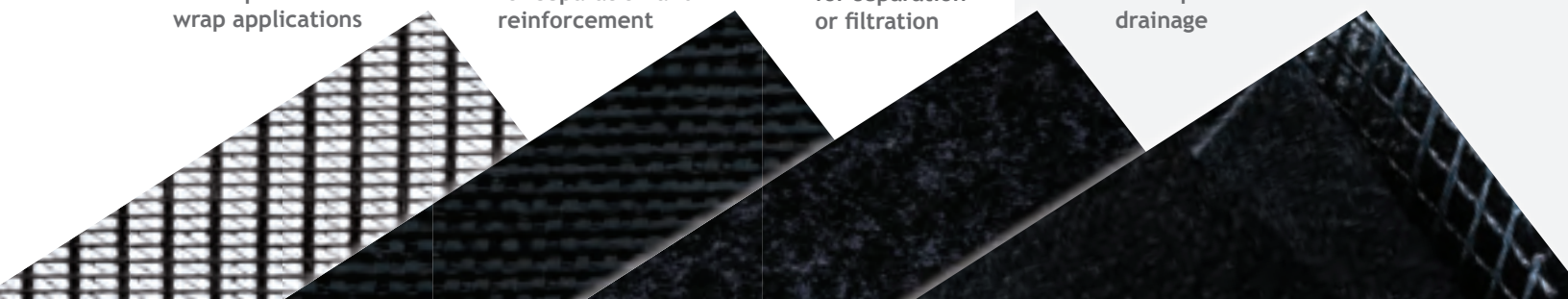
## *StrataTex*

**NON-WOVEN**

**Geotextiles for separation or filtration**

## *StrataDrain*™

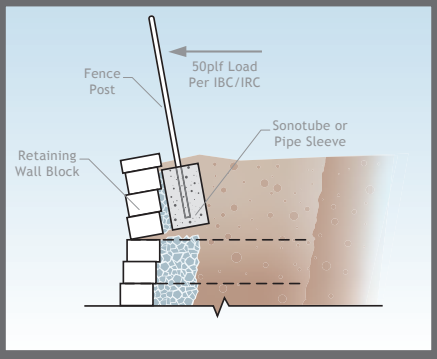
**High-flow, fusion-bonded, geonet-geotextile composites for improved soil drainage**



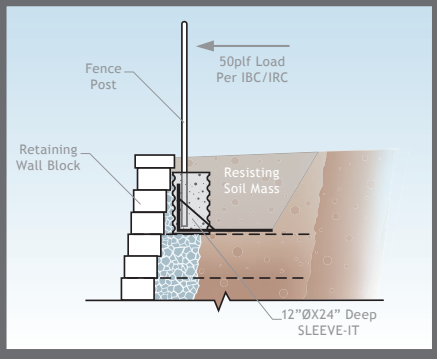
## *Introducing Sleeve-It™*

**The industry's first pre-engineered fencing foundation for segmental retaining walls**

*Without Sleeve-It™*




*With Sleeve-It™*




## *Sleeve-It™*

**A code compliant, fence-post anchoring system for integrating stable fence footings into the construction of retaining walls.**

## *Step 1*

Install the cantilevered Sleeve-It units near the elevation of the top of wall

## *Step 2*

Fill and compact soil up to the top of the sleeve

## *Step 3*

Leave the disposable lid on the sleeve until the fence installer places the fence post in the sleeve and fills with concrete

## *Step 4*

The fencing contractor finishes the fence, supported by the buried Sleeve-It system

## Consider Stratagrid® Soil Reinforcement

### *Applications*

- Segmental retaining walls
- Temporary walls and slopes
- Reinforced steep slopes
- Reinforced embankments
- Soft soils

### *Markets*

- Commercial development
- Residential development
- Infrastructure development
- Environmental site development
- Pedestrian safety (Sleeve-It™)

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STRATA
Global GeoSolutions
www.geogrid.com

1.800.680.7750 380 Dahlonega Road, Suite 200, Cumming, Georgia 30040