

# **CHAPTER 2**

# **GLOSSARY**

## **GEOTECHNICAL DESIGN MANUAL**

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**Table of Contents**

<b><u>Section</u></b>		<b><u>Page</u></b>
2.1	Introduction.....	2-1
2.2	Definitions.....	2-1

**Table of Figures**

<b><u>Figure</u></b>	<b><u>Page</u></b>
Figure 2-1, Bridge Embankment using Geotechnical Mitigation.....	2-3
Figure 2-2, Bridge Embankment using Structural Mitigation .....	2-4

# CHAPTER 2

## GLOSSARY

### 2.1 INTRODUCTION

The purpose of this Chapter is to provide consistent definitions of key words and concepts that will be used throughout the GDM. Some of the definitions used herein are exclusive to the GDM, while others are borrowed from the SCDOT Bridge Design Manual (2006) (BDM) or from the SCDOT Seismic Design Specifications for Highway Bridges (2008) (Seismic Specs). Additional definitions are also borrowed from the AASHTO LRFD Specifications referenced in either the BDM or the Seismic Specs. Where there is potential conflict between the GDM and any of these other sources, the GDM shall govern, unless specifically indicated otherwise.

### 2.2 DEFINITIONS

**Active Earth Pressure Coefficient,  $K_a$**

The coefficient of lateral pressure that is developed when a structure, either an Earth Retaining Structure (ERS) or an abutment wall moves away from the backfill resulting in a decrease in pressure on the structure relative to the at-rest pressure.

**Alternate Profiles**

Alternate profiles are sometimes necessary when evaluating settlements; these profiles are typically parallel to the alignment of the roadway at a location that is subject to larger settlements than those at the Profile Grade location; alternately, this profile may be transverse to the Profile Grade and is used to determine differential settlement.

**Apparent Opening Size, AOS ( $O_{95}$ )**

A property which indicates the approximate largest particle that would effectively pass through a geotextile.

**Approach Slab**

A reinforced concrete structural slab placed on the embankment to transition from the roadway pavement to the bridge surface at the end bent; approach slabs are typically 20 feet in length.

**Argillaceous Geomaterials**

Geomaterials that contain a significant clay fraction (CF) (12 to 40 percent) within the soil matrix.

**At-Rest Earth Pressure Coefficient,  $K_o$**

The coefficient of lateral pressure that exists in level ground for the condition of no lateral deformation.

**Backwall Height**

The distance measured from the bottom of the bent cap to the top of the bridge deck at the beginning or end of bridge. The backwall height is typically measured at the centerline of the bridge, but shall be taken as the largest height along the bent at the beginning or

end of bridge. For cored slab superstructures, exclude the wearing surface from the backwall height.

**Blinding**

Condition whereby soil particles block the surface openings of a geotextile, thereby reducing the hydraulic conductivity.

**Bridge Embankment**

The portion of the approach embankment that requires an Extreme Event limit state global stability check, unless indicated otherwise within the GDM. The longitudinal length of Bridge Embankment shall be based on the specified mitigation method (either geotechnical or structural) that is required to achieve satisfactory global stability for the Extreme Event limit state check.

Geotechnical Mitigation Required: The Bridge Embankment shall include the front slope and shall extend from either the end of the approach slab plus 3.25 times the height of the backwall, if the approach slab is present, or to the point where the need for geotechnical mitigation terminates, whichever is longer (see Figure 2-1) in the longitudinal direction. The extent of transverse mitigation, if required, shall be limited to the “Minimum Bridge Embankment Using Geotechnical Mitigation” as depicted in Figure 2-1.

Structural Mitigation Required: The Bridge Embankment shall include the front slope plus 3.25 times the height of the backwall measured from the end of the approach slab, if present (see Figure 2-2). This distance shall be taken as the minimum Bridge Embankment.

In the event mitigation is not required for the Extreme Event limit state global stability analysis, the Bridge Embankment shall include the front slope plus 3.25 times the height of the backwall measured from the end of the approach slab, if present (see Figure 2-2).

**California Bearing Ratio (CBR)**

The ratio of (1) the force per unit area required to penetrate a soil mass with a 3-square-inch circular piston (approximately 2-inch diameter) at the rate of 0.05 inches/minute to (2) the force per unit area required for corresponding penetration of a standard method.

**Cantilever ERS**

An ERS that prevents the advance of an in situ soil mass and is typically constructed from the top of the wall to the base concurrent with excavation operations of the in-situ soil to be removed; cantilever retaining ERS can either be constructed with or without anchors; typical cantilever ERSs used are Sheet Pile Wall with and without anchors, Soldier Pile Wall and Lagging with and without anchors, Tangent/Secant Pile Wall with and without anchors, and Soil Nailed Wall.

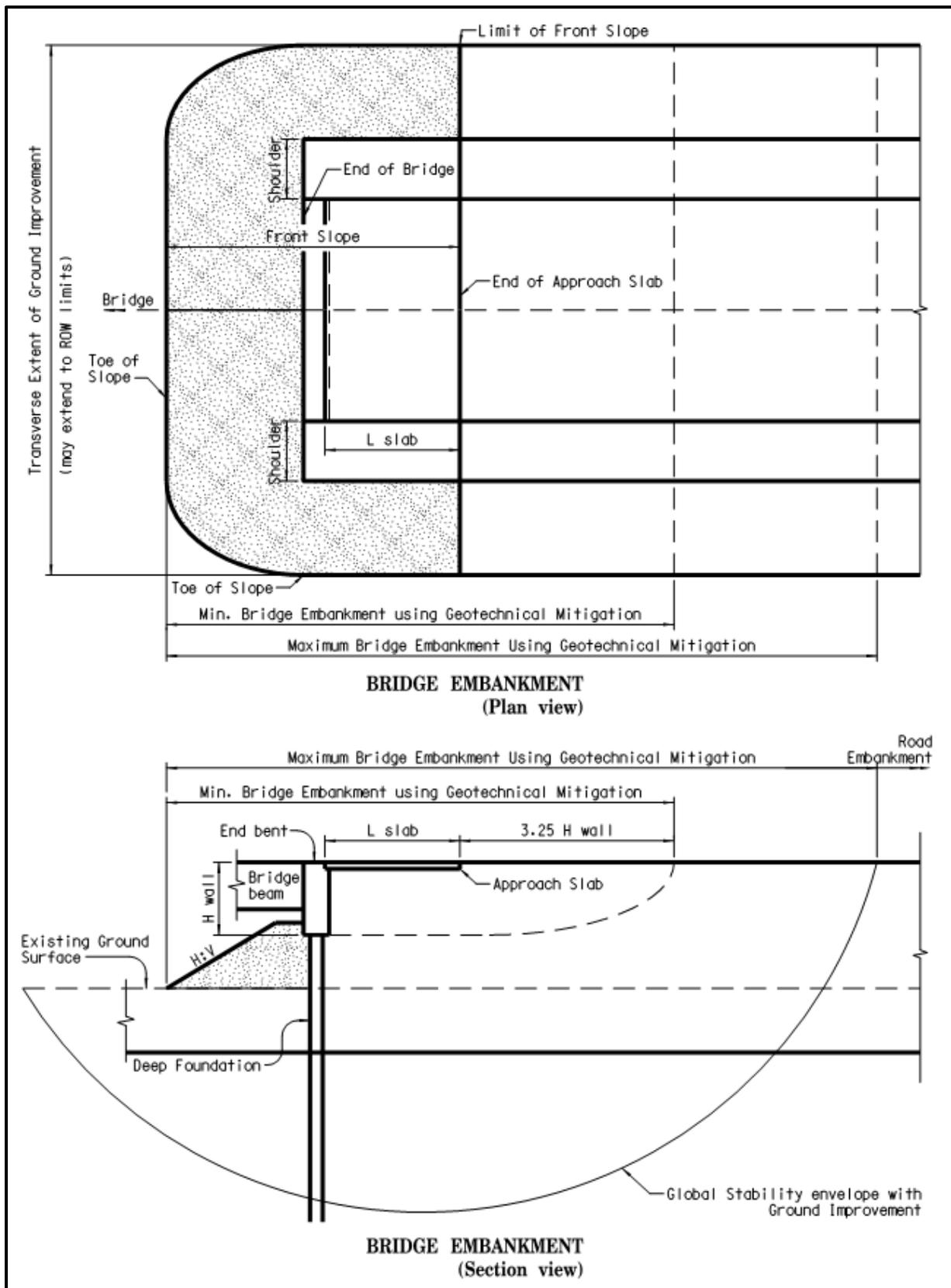


Figure 2-1, Bridge Embankment using Geotechnical Mitigation

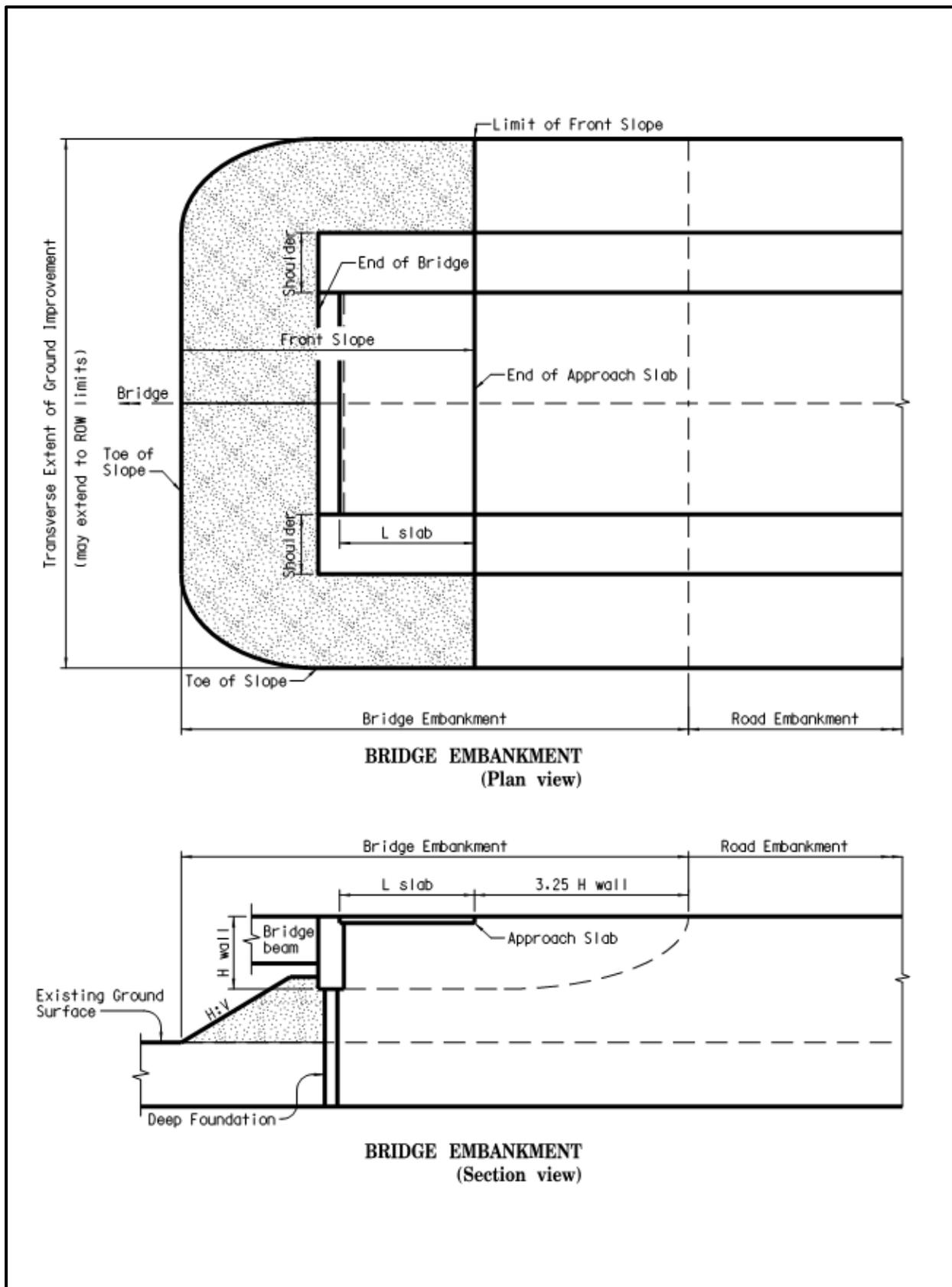


Figure 2-2, Bridge Embankment using Structural Mitigation

<b>Check Flood</b>	Storm surge, tide or mixed population flood shall be the more severe of the 500-year flood event (0.2 percent Annual Exceedance Probability (AEP)) or from an overtopping flood of lesser recurrence interval; the Extreme Event II limit state shall apply.
<b>Clogging</b>	Condition where soil particles move into and are retained in the openings of a geotextile, thereby reducing hydraulic conductivity.
<b>Critical Penetration</b>	The minimum embedded pile length to prevent rotation or inclination of the pile in the ground (i.e., to prevent soil failure) when a lateral load is applied at the top of the pile.
<b>Cross-machine Direction</b>	The direction in the plane of the geosynthetic perpendicular to the direction of manufacture.
<b>Cross Section</b>	A slice or section taken perpendicular to the roadway alignment at a specific location (station) of the road.
<b>DB/GDS</b>	Design Build – Geotechnical Design Section.
<b>DCE</b>	District Construction Engineer.
<b>Design Flood</b>	Storm surge, tide or mixed population flood shall be the more severe of the 100-year flood event (1.0 percent Annual Exceedance Probability (AEP)) or from an overtopping flood of lesser recurrence interval.
<b>DME</b>	District Maintenance Engineer.
<b>Drained Strength</b>	Shear strength when there is no change in effective stress on the failure plane.
<b>Earth Retaining Structure (ERS)</b>	<p>An engineered structural system that prevents the lateral advance of a soil mass by resisting the lateral earth pressures exerted by the soil; ERSs shall have a face angle greater than or equal to 70° above the horizontal; ERSs have been classified for Strength limit state design by the type of retaining system as follows:</p> <ul style="list-style-type: none"><li>• Rigid Gravity ERS</li><li>• Flexible Gravity ERS</li><li>• Cantilever ERS</li></ul> <p>Further, ERSs are also classified based on the construction method Fill ERS, bottom-up, or Cut ERS, top-down.</p>
<b>Effective Stress</b>	The stress that includes only the forces (loads) that are transmitted (carried) by grain-to-grain contact.

<b>Embankment</b>	An earthen mass structure constructed from select fill material placed in compacted lifts over competent soil (natural or improved) capable of supporting the structure; there are 2 types of embankments: bridge and roadway; embankments have face angles of less than 70° above the horizontal.
<b>Embankment Widening</b>	An embankment is considered to be widened when the centerline of the embankment is shifted more than 1/2 of the width of the travelway (all travel lanes combined) in either transverse direction or if 1 travel lane is added in each direction and the centerline of the embankment does not change.
<b>ERS Profile</b>	A profile of the wall that indicates the top of the wall, the location where the wall intersects the natural ground and the bottom of the wall (embedment depth of the wall below natural ground); wall profiles typically have their own alignment and stationing and are tied in to the project alignment.
<b>ERS Cross Section</b>	A slice or section taken perpendicular to the wall profile at a specific location (station).
<b>Failure Surface</b>	An approximation of the most likely shear failure surface that will develop as a result of instability of an earthen mass; typically this surface has the highest resistance factor ( $\phi > 1.0$ ); a failure surface is not considered present if the resistance factor is equal to or less than 1.0 ( $\phi \leq 1.0$ ); the surface may be either circular or non-circular.
<b>Filtration</b>	The process of retaining soils while allowing the passage of water (fluid).
<b>Flexible Gravity ERS</b>	Flexible gravity walls are typically constructed bottom-up (fill) that have flexible facings and flexible structural elements such as those used in Gabion Wall, MSE (Full Height Panel Facing), MSE (Modular Block Facing), MSE (Precast Panel Facing), MSE (Gabion Facing), and Geosynthetic Reinforced Soil Slopes (face slopes greater than or equal to 70°).
<b>Flow Failure</b>	The horizontal and/or vertical displacement of sloping ground that occurs when the induced static shear stresses exceed the shear strength of the soil that has undergone SSL and any overlying soils (i.e., use peak shear strength for the overlying soils). Note that structures (including bridge embankments) built on such a slope will likely undergo severe damage due to the large and unpredictable magnitudes of displacement associated with this failure mechanism. Displacements are anticipated to measure from feet to hundreds of feet depending on the size and pitch of the sloping ground.
<b>Front Slope</b>	The embankment that extends beneath the bridge and to the end of the approach slab (see Figure 10-1); the front slope begins at the

end bent and extends longitudinally from the existing ground surface in front of the end bent to the end of the approach slab and extends transversely to existing ground surface on the sides; front slope grades are given in ratios of horizontal distance to vertical height (i.e., 2(H):1(V)); for bridges without approach slabs, the front slope shall extend 20 feet from either “begin” or “end” of bridge.

**Functional Evaluation****Earthquake (FEE)**

The ground shaking having a 15 percent probability of exceedance in 75 years (15%/75yr) and is equal to the 10 percent probability of exceedance in 50 years (10%/50yr); the FEE PGA and PSA are used for the functional evaluation of transportation infrastructure; annual probability of exceedance ( $P_E$ ) is  $2.11 \times 10^{-3}$ .

**GEC**

Geotechnical Engineering Consultant, a consultant, specializing in geotechnical engineering, hired by SCDOT to provide geotechnical services including field, laboratory and engineering services, that SCDOT either does not perform or has insufficient personnel to provide the service.

**Geocell**

A 3-dimensional comb-like structure that may be filled with soil, aggregate or concrete.

**Geocomposite**

A geosynthetic material manufactured of 2 or more geo-materials (i.e., geomembrane and geonet combination).

**Geogrid**

A geosynthetic formed by a regular network of tensile elements and apertures, typically used for reinforcement applications.

**Geomembrane**

An essentially impermeable geosynthetic, typically used to control fluid migration.

**Geonet**

A geosynthetic consisting of integrally connected parallel sets of ribs overlying similar sets of ribs, for planar drainage of liquids or gases

**GEOR**

Geotechnical Engineer-of-Record.

**Geosynthetic**

A planar product manufactured from polymeric material used with soil, aggregate, or other geotechnical engineering materials.

**Geotechnical Mitigation**

When ground improvement or ground reinforcement is used to minimize loads and deflections induced by global instability that occur during the appropriate limit state check from being transferred to the bridge structure. Typically geotechnical mitigation extends from either the toe of slope (see Figure 2-1) or outside of the toe slope and extends beyond the begin/end of bridge to a point where the global stability analysis surface exits the ground surface and achieves an appropriate resistance factor for the limit state being

examined. If vertical elements other than the bridge foundation are used as the selected mitigation method, contact the OES/GDS for further guidance. Further, geotechnical mitigation is typically limited transversely by the Right-of-Way lines. If geotechnical mitigation is only required to maintain stability in the transverse direction, the longitudinal extent of transverse mitigation shall extend from the limit to the end of the front slope (see Figure 2-1) plus 3.25 times the height of the backwall measured from the end of the approach slab, if present.

<b>Geotextile</b>	A permeable geosynthetic comprised solely of textiles.
<b>Global Instability</b>	An imbalance of the driving and resisting forces of an earthen mass that causes a shear failure surface to occur and consequently causing the earthen mass to deform.
<b>Global Stability Analysis</b>	An estimation of the balance between the driving forces (demand) and resisting forces (capacity) within an earthen mass that is seeking to maintain equilibrium.
<b>Gravity ERS</b>	An ERS that prevents the advance of select fill materials placed during construction and is constructed from the base to the top of the wall.
<b>HEOR</b>	Hydraulic Engineer-of-Record.
<b>Index Test</b>	A test procedure which may contain a known bias but which may be used to establish an order for a set of specimens with respect to the property of interest.
<b>Intermediate Geomaterials (IGM)</b>	Earth materials with properties at the boundary between soil and rock that display properties of both materials; the required properties are discussed in Chapter 6.
<b>Lateral Spread</b>	The horizontal displacement of gently sloping ground ( $\leq 6^\circ$ ) or virtually level ground towards a free face that is typically adjacent to a water way and occurs during a seismic event when the subgrade soils undergo SSL. In addition, the static shear stresses induced by the structure do not exceed the shear strength of the soil that has undergone SSL and any overlying soils (i.e., use peak shear strength for the overlying soils). Note that structures (including bridge embankments) built on such a slope may undergo minor to severe damage depending on the amount of displacement. Displacements are anticipated to incrementally accumulate during the seismic shaking and measure from inches to feet. Also called “cyclic mobility” in the literature.
<b>Machine Direction</b>	The direction in the plane of the geosynthetic parallel to the direction of manufacture.

<b>Maximum Average Roll Value (MaxARV)</b>	A quality control tool used by geosynthetic manufacturers to establish and publish <u>maximum</u> property values.
<b>Minimum Average Roll Value (MARV)</b>	A quality control tool used by geosynthetic manufacturers to establish and publish <u>minimum</u> property values.
<b>NAVD 88</b>	North American Vertical Datum of 1988
<b>OES/GDS</b>	Office of Engineering Support – Geotechnical Design Section includes the Geotechnical Design Section within the Office of Engineering Support.
<b>OES/HDS</b>	Office of Engineering Support – Hydraulic Design Section includes the Hydraulic Design Section within the Office of Engineering Support.
<b>OES/SDS</b>	Office of Engineering Support – Structural Design Section includes Structural Design Section within the Office of Engineering Support.
<b>Passive Earth Pressure Coefficient, <math>K_p</math></b>	The coefficient of lateral pressure that is developed when, either an ERS or an abutment wall moves toward the backfill resulting in an increase in pressure on the structure relative to the at-rest pressure.
<b>Peak Shear Strength</b>	The maximum shear stress that a soil can withstand, $\tau_{Peak}$ .
<b>Permeability</b>	The rate of flow of a fluid under a differential pressure through a material.
<b>Permittivity</b>	The volumetric flow rate of water per unit cross sectional area per unit head under laminar flow conditions, in the normal direction through a geotextile.
<b>Pore Pressure</b>	The force (load) transmitted (carried) by the interstitial water (i.e., the water contained in the pore spaces).
<b>Profile Grade</b>	Roadway plans typically have plan and profile sheets; the profiles are given along a specific location of the pavement surface that is referred to in the plans as the Profile Grade (P.G.) or Finished Grade (F.G.); often this location is the same as the centerline of the road; there may be multiple profile grades along a divided roadway or intersection for each traffic direction; the location of the roadway alignment in plan view typically coincides with the location of the profile grade.

<b>Quality Control</b>	The operational techniques and activities used to verify requirements for quality.
<b>Quality Assurance</b>	All planned and systematic activities implemented within the quality system that verifies a product or service fulfills quality requirements.
<b>RCE</b>	Resident Construction Engineer.
<b>Reinforced Embankment</b>	An embankment that typically has a face angle less than 1H:1V but greater than 2H:1V, and requires the use of geosynthetic reinforcement within the embankment to maintain stability; a reinforced embankment can use borrow materials as defined in the Standard Specifications.
<b>Reinforced Soil Slope (RSS)</b>	An embankment that typically has a face angle greater than or equal to 1H:1V but less than 70°, has geosynthetic or metallic reinforcement within the embankment and generally has a face element of some kind (see Chapter 17 for face elements).
<b>REOR</b>	Roadway Engineer-of-Record.
<b>Residual Shear Strength</b>	The minimum shear stress that a soil can maintain regardless of the amount of displacement, $\tau_r$ .
<b>Right-of-Way (ROW)</b>	A privilege to pass over the land of another in some particular path; usually an easement over the land of another; a strip of land used in this way for railroad or highway purposes, for pipelines or pole lines, and for private or public passage.
<b>Rigid Gravity ERS</b>	Rigid gravity ERSs are typically constructed bottom-up (fill) that have rigid facings and rigid structural elements such as those used in Concrete Barrier Walls, Concrete Retaining Walls, and Concrete Stem (cantilever) walls with and without buttresses; rigid gravity ERSs depend on the mass (weight) of the concrete to resist the driving forces placed on the wall.
<b>RCE</b>	Resident Construction Engineer.
<b>RME</b>	Resident Maintenance Engineer.
<b>Roadway Embankment</b>	The portion of the embankment that extends beyond the bridge embankment and extends between the toes of the slopes on either side.
<b>Rock</b>	Naturally occurring solid aggregate of minerals that occur in large masses or fragments; consolidated accumulation of solid particles.

<b>RPG/GDS</b>	Regional Production Group – Geotechnical Design Section includes the Geotechnical Design Sections within each Regional Production Group and the Design Build Section.
<b>RPG/HDS</b>	Regional Production Group – Hydraulic Design Section includes the Hydraulic Design Sections within each Regional Production Group and the Design Build Section.
<b>RPG/SDS</b>	Regional Production Group – Structural Design Section includes Structural Design Sections within each Regional Production Group and the Design Build Section.
<b>Safety Evaluation Earthquake (SEE)</b>	The ground shaking having a 3 percent probability of exceedance in 75 years (3%/75yr) and is equal to the 2 percent probability of exceedance in 50 years (2%/50yr); the SEE PGA and PSA are used for the safety evaluation of transportation infrastructure. Annual probability of exceedance ( $P_E$ ) is $4.04 \times 10^{-4}$ .
<b>SEOR</b>	Structural Engineer-of-Record.
<b>Side Slopes</b>	The embankment that extends perpendicular to the travelway and has been graded to meet traffic safety and stability requirements; the side slope begins at the shoulder break and extends to the existing ground surface; side slope grades are given in ratios of horizontal distance to vertical height (i.e., 3(H):1(V)), transverse to the roadway travel direction.
<b>Standard Specifications</b>	The <u>Standard Specifications for Highway Construction</u> , latest version as published by SCDOT; the Standard Specifications also includes Supplemental Specifications, Supplemental Technical Specifications and Special Provisions.
<b>Soil</b>	Sediment or other unconsolidated accumulation of solid particles produced by the physical and chemical disintegration of rock materials which may or may not contain organic matter.
<b>Soil Shear Strength Loss (SSL)</b>	The reduction in soil shear strength caused by seismically induced cyclic loading of soil; in loose cohesionless soils this is termed cyclic liquefaction while in plastic cohesive soils, SSL is termed cyclic softening.
<b>Station</b>	Locations along a reference base line on the plan or profile that is based on measurements from a reference point (i.e., Sta. 1+00.00 = 100.00 feet).

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<b>Structural Mitigation</b>	When bridge structural elements are used to resist loads and deflections induced by global instability that occurs during the appropriate limit state check.
<b>Temporary</b>	Structure or embankment having a design life of 5 years or less.
<b>Transmissivity</b>	The volumetric flow rate of water per unit cross sectional area per unit head under laminar flow conditions, in the in-plane direction through a geotextile.
<b>Total Stress</b>	The stress that includes all of the forces (loads) that are transmitted (carried) by not only grain-to-grain contact but also by the interstitial water.
<b>Undrained Strength</b>	Shear strength when there is no change in water content (i.e., no volume change).
<b>Unreinforced Embankment</b>	An embankment that typically has a face angle flatter than or equal to 2H:1V; an unreinforced embankment can use borrow materials as defined in the Standard Specifications.