



# Geotechnical Solutions for Transportation Infrastructure: A Web-based Information and Guidance System

**Vern Schaefer – Iowa State University**

**Arizona Pavements / Materials Conference  
Arizona State University, Tempe, AZ  
November 16, 2011**



# **What are Geotechnical Solutions? (Construction Options)**

## **Geoconstruction and Ground Improvement Methods and Systems**

- ❖ Methods to alter poor soil/ground conditions to meet project requirements**
- ❖ Variety of methods, often categorized by densification, reinforcement or stabilization**

# R02 Project Elements

- 1 Construction of new embankments and roadways over areas of unstable soils**
- 2 Widening and expansion of existing embankments and roadways**
- 3 Improvement and stabilization of the support beneath the pavement structure**

# Project Team

## Project Principals

**Vern Schaefer, ISU**

**David White, ISU**

**George Filz, VT**

**Jie Han, KU**

**Jim Mitchell, VT**

**Linbing Wang, VT**

**Ryan Berg, Consultant**

**Barry Christopher, Consultant**

**Jim Collin, Consultant**

**Donald Bruce, Consultant**

**Gary Fick, Consultant**

**Dennis Turner, Consultant**

## VT, ISU & KU Students/Researchers

# Advisory Board Members

## State DOT Representatives

James Brennan	Kansas DOT
David Horhota	Florida DOT
Mark Morvant	Louisiana TRC
Hooshmand Nikoui	Caltrans
David Shiells	Virginia DOT
John Siekmeier	Minnesota DOT

## Design/Build Contractor Representatives

Allen Cadden	Schnabel Engineering
Mike Cowell	GeoConstructors, Inc.
Seth Pearlman	DGI-Menards, Inc.
Steve Saye	Kiewit Engineering
Al Sehn	Hayward Baker Inc.

# Phase 1 Overview

Oct 2007 to Sept 2008

- **Task 1 – List of technologies & categorized bibliography**
- **Task 2 – Technical Issues**
- **Task 3 – QA/QC procedures**
- **Task 4 – Constraints**
- **Task 5 – Mitigation Strategies**
- **Task 6 – Report & Phase 2 Plan**

# 46 Technologies Addressed

- **Aggregate Columns**
- **Beneficial Reuse of Waste Materials**
- **Bio-Treatment for Subgrade Stabilization**
- **Blast Densification**
- **Bulk-Infill Grouting**
- **Chemical Grouting/ Injection Systems**
- **Chemical Stabilization of Subgrades & Bases**
- **Column-Supported Embankments**
- **Combined Soil Stabilization with Vertical Columns**
- **Compaction Grouting**
- **Continuous Flight Auger Piles**
- **Deep Dynamic Compaction**
- **Deep Mixing Methods**

## 46 Technologies Addressed *(cont.)*

- **Drilled/Grouted & Hollow Bar Soil Nailing**
- **Electro-Osmosis**
- **Excavation & Replacement**
- **Fiber Reinforcement in Pavement Systems**
- **Geocell Confinement in Pavement Systems**
- **Geosynthetic Reinforced Construction Platforms**
- **Geosynthetic Reinforced Embankments**
- **Geosynthetic Reinforcement in Pavement Systems**
- **Geosynthetic Separation in Pavement Systems**
- **Geosynthetics in Pavement Drainage**
- **Geotextile Encased Columns**
- **High-Energy Impact Rollers**
- **Hydraulic Fill + Vacuum Consolidation + PVDs**
- **Injected Light-Weight Foam Fill**

## 46 Technologies Addressed *(cont.)*

- **Intelligent Compaction**
- **Jet Grouting**
- **Light Weight Fills**
- **Mechanical Stabilization of Subgrades & Bases**
- **MSE Walls**
- **Micro-Piles**
- **Onsite Use of Recycled Pavement Materials**
- **Partial Encapsulation**
- **PVDs & Fill Preloading**
- **Rapid Impact Compaction**
- **Reinforced Soil Slopes**
- **Sand Compaction Piles**
- **Screw-In Soil Nailing**
- **Shoot-In Soil Nailing**
- **Shored MSE Walls**
- **Traditional Compaction**
- **Vacuum Preloading w/ & w/o PVDs**
- **Vibrocompaction**
- **Vibro-Concrete Columns**

# Phase 2 Work Tasks

Nov 2007 to Dec 2011

- **Six tasks:**
  8. **Test and evaluate the effectiveness of mitigation methods**
  9. **Develop a catalog of materials & systems for rapid renewal**
  10. **Refine/develop design procedures, QA/QC processes & guidance for geotechnical materials & systems**
  11. **Develop methods for estimating costs of geotechnical & materials systems**
  12. **Develop sample guide specifications for geotechnical & materials systems**
  13. **Final report**

# End User Products

- **Main product: Web based information and guidance system**
- **Development project reports**
- **Within the G&S system, for each of 46 technologies:**
  - ❖ **Technology Fact Sheets**
  - ❖ **Photographs**
  - ❖ **Case Histories**
  - ❖ **Design Procedures**
  - ❖ **Quality Control/Quality Assurance Procedures**
  - ❖ **Cost Estimating**
  - ❖ **Specifications**
  - ❖ **Bibliography**

# Audience

- **Public agency personnel at local, state and federal levels**
  - ❖ **Primarily Geotechnical Engineers**
  - ❖ **Civil/Structural/Bridge Design & Construction Engineers, Pavement Design & Construction Engineers**
  - ❖ **Project Managers, Procurement, Research, Maintenance, District Engineers**
- **Consultants, General Contractors, A/E groups, Academics/Students**

# Product Use

- **Web site**
  - ❖ **Learn about technologies, both technical and nontechnical users**
  - ❖ **Investigate candidate solutions, by category classification or using selection system**
  - ❖ **Locate design methods, quality methods**
  - ❖ **Develop cost estimates**
  - ❖ **Develop specifications**
  - ❖ **Technical summaries**
- **Locate additional information in references**

# Goal of Information & Guidance System

***To make geotechnical solutions more accessible to public agencies in the United States for rapid renewal and improvement of the transportation infrastructure.***

***"Project Vision"***

# Objectives of the System

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**1. Identify potential technologies for design and construction for the following transportation applications:**

- ❖ **Construction over UNSTABLE soils**
- ❖ **Construction over STABLE or STABILIZED soils**
- ❖ **Geotechnical pavement components (base, subbase, and subgrade)**
- ❖ **Working platforms**

# Objectives of the System

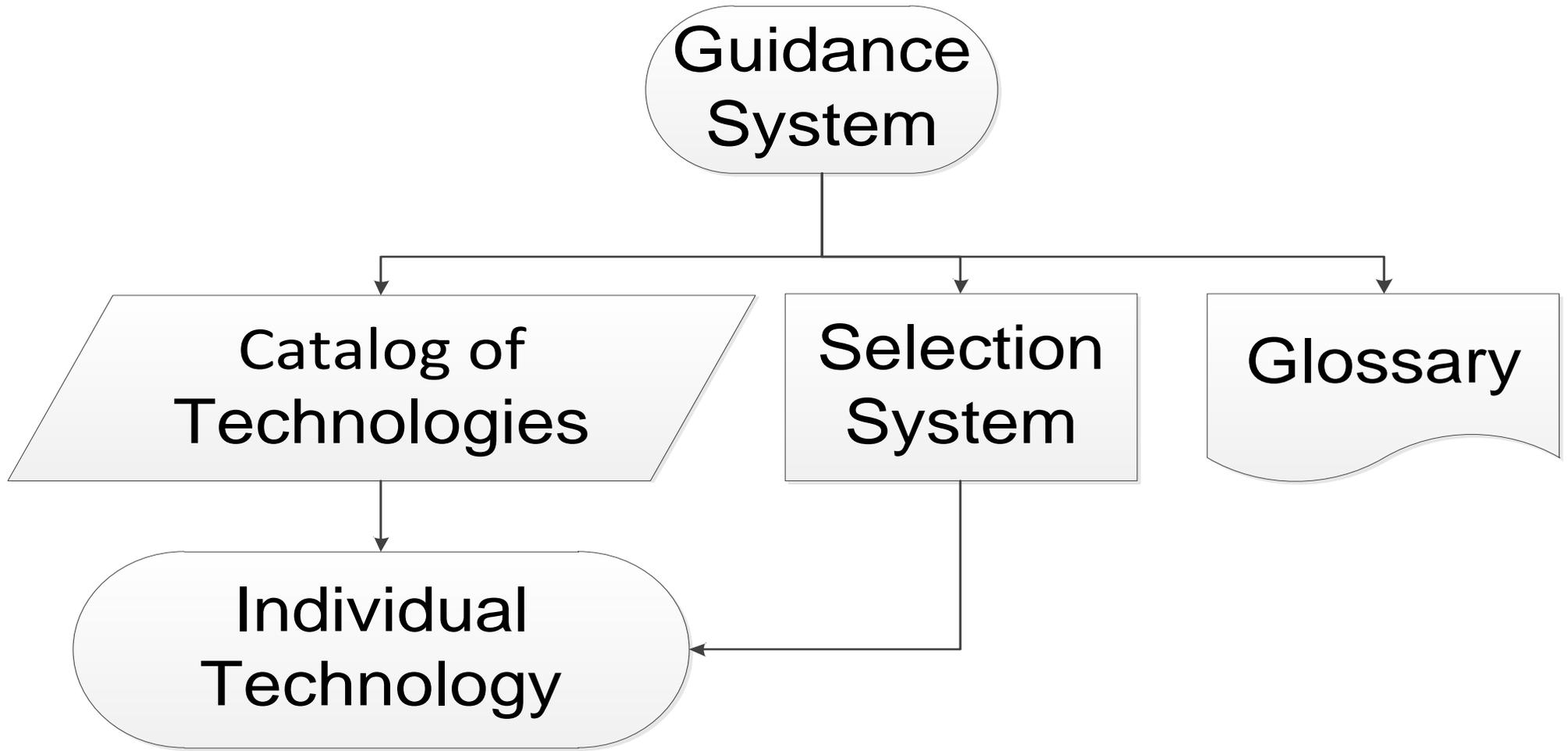
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- 2. Provide guidance to develop a ‘short-list’ of applicable technologies**
- 3. Provide guidance for detailed project-specific screening of technologies with consideration of SHRP 2 Renewal Objectives**
- 4. Provide an interactive, programmed system**
- 5. Provide current, up to-date information**

# System Mandates

- **The information and guidance system should be:**
  - ❖ **Simple**
  - ❖ **Functional**
  - ❖ **Completely populated**
  - ❖ **Selection system should guide user to a short-list of potential, unranked technologies.**
  - ❖ **Should be easily updatable**

# System Structure



# Considerations for Selection System Development

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- **Framework required addressing five areas:**
  - 1. Overall system characteristics**
  - 2. The user**
  - 3. The knowledge**
  - 4. The operating system**
  - 5. Approach to the system**

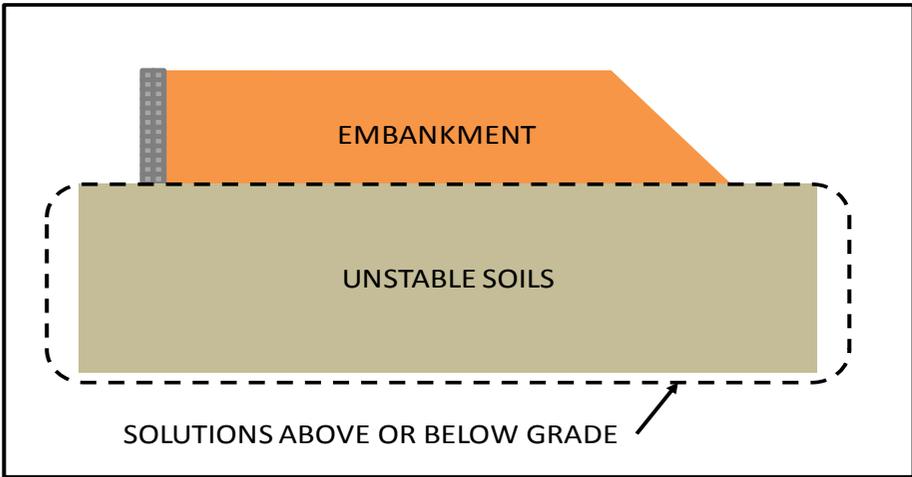
# Getting Started...

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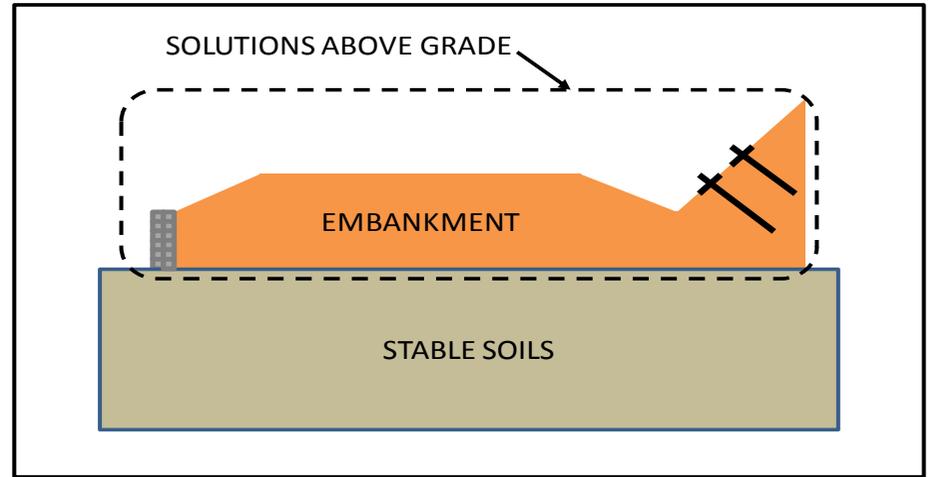
- **What is the application?**
- **What is the soil condition that needs to be improved?**
- **To what depth do the unstable soils extend?**

# Value Added

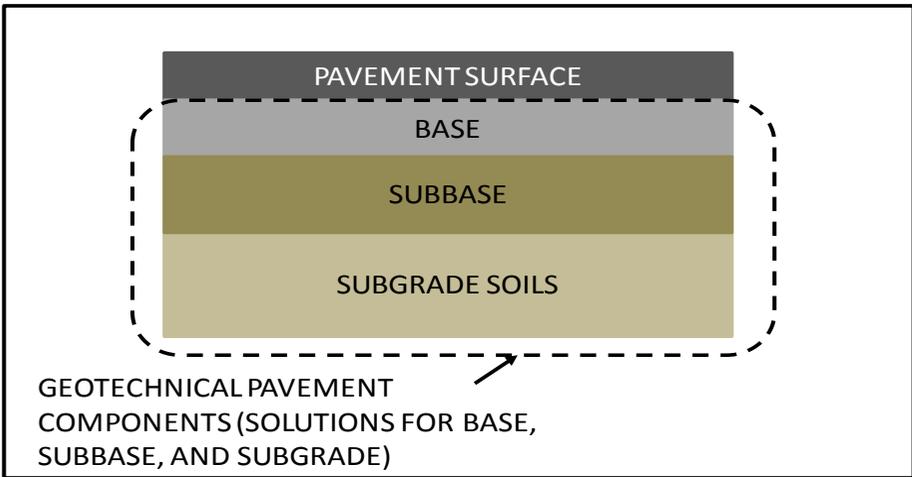
- Main product: Web based information and guidance system
- The primary value of the system is that it collects, synthesizes, integrates, and organizes a vast amount of critically important information about geotechnical solutions in a system that makes the information readily accessible to the transportation agency personnel who need it most.



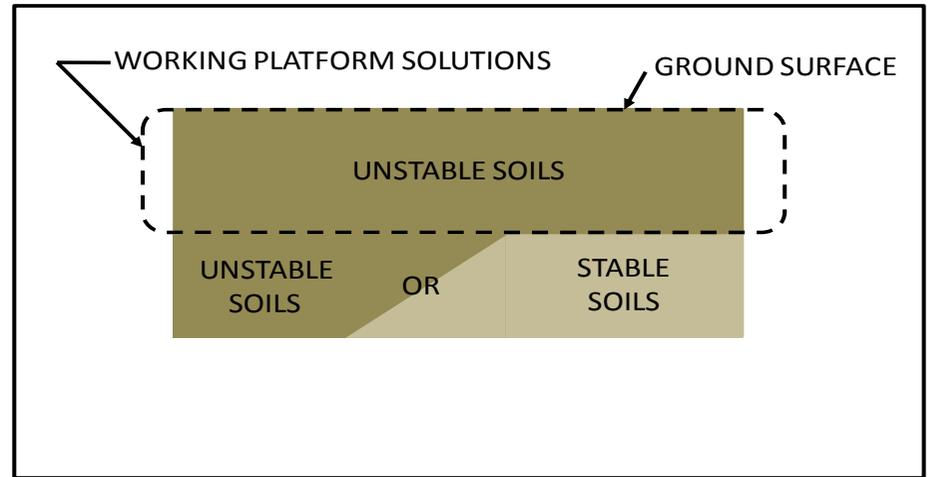
Construction over Unstable Soils



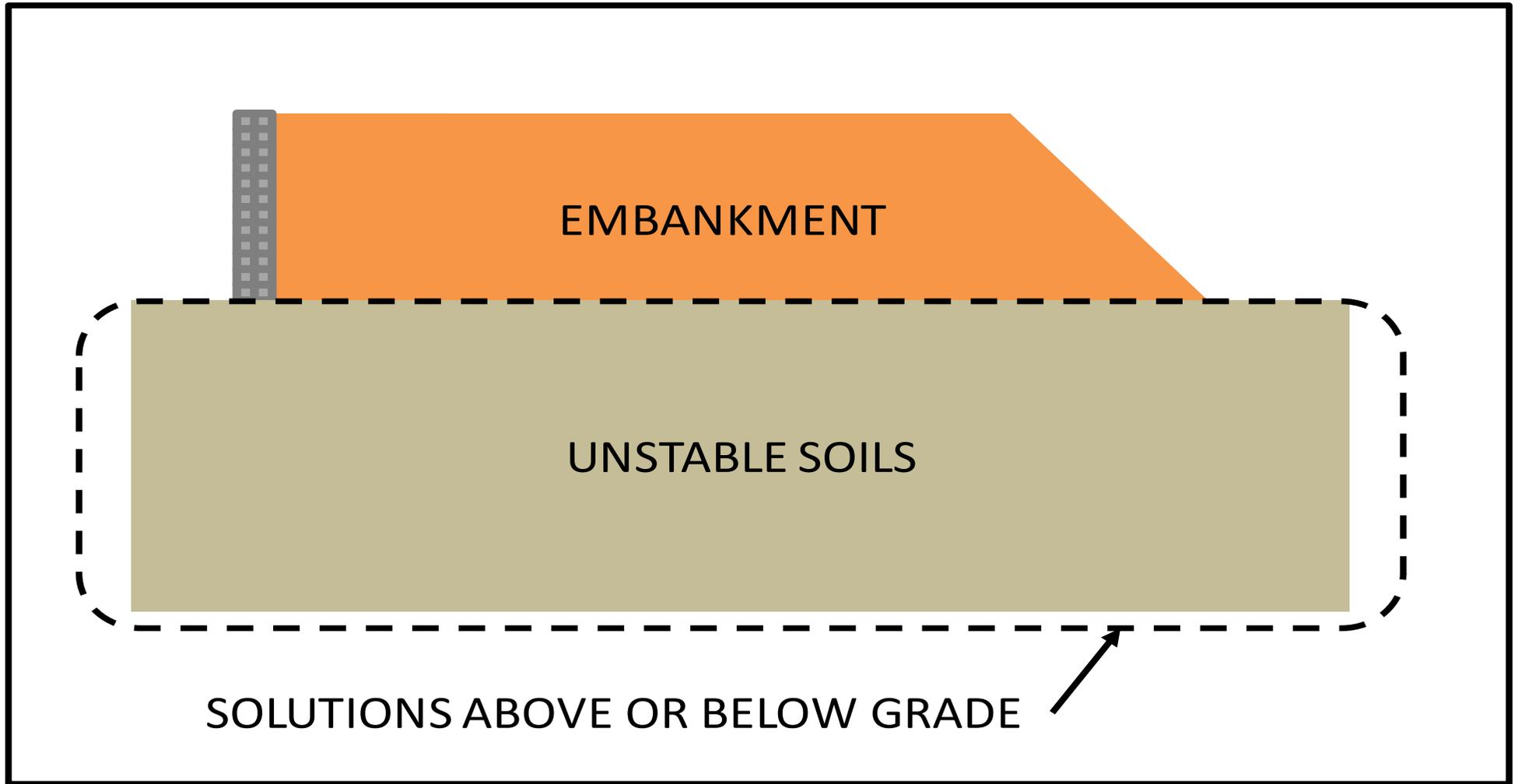
Construction over STABLE/STABILIZED Soils



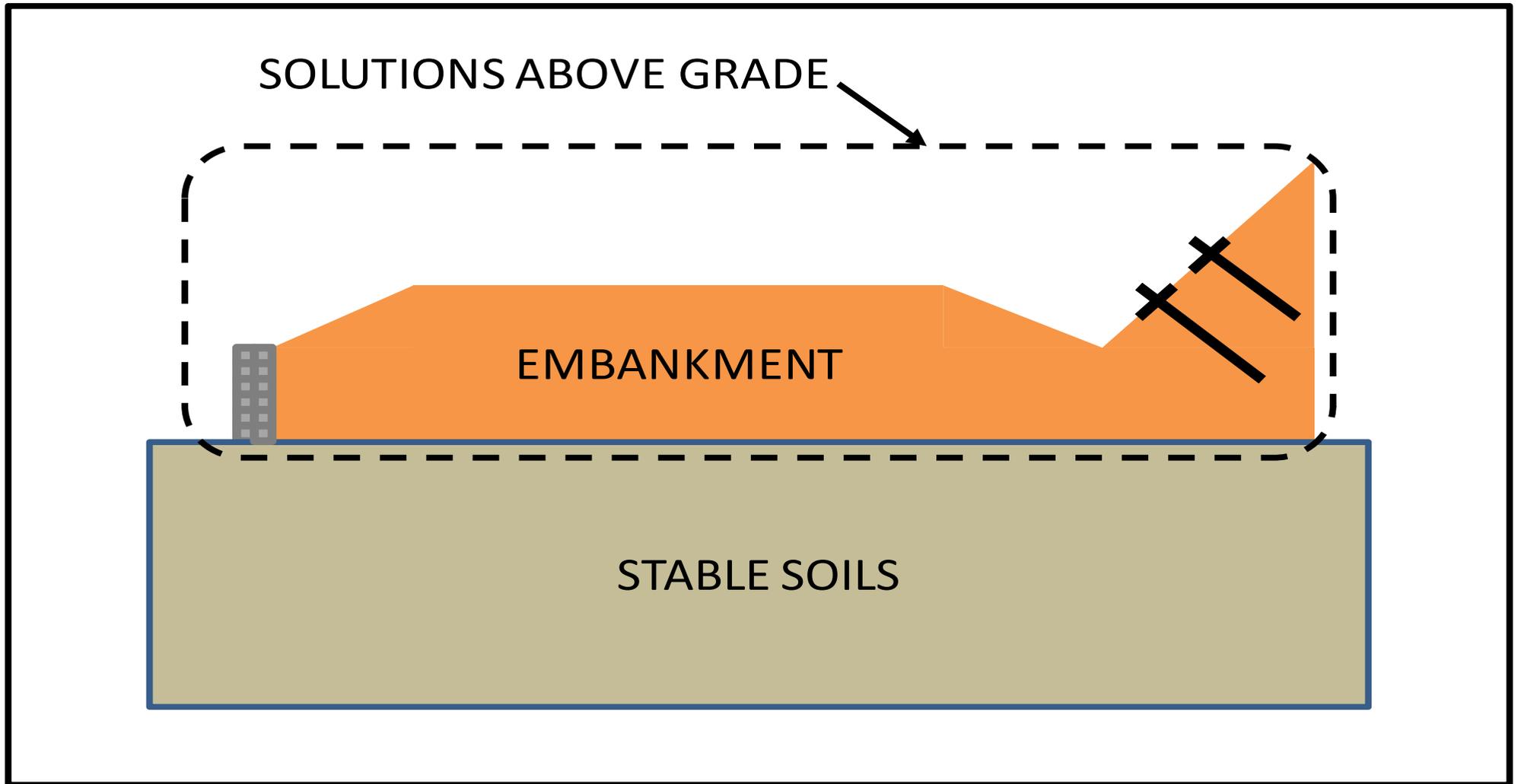
Geotechnical Pavement Components (Base, Subbase, and Subgrade)



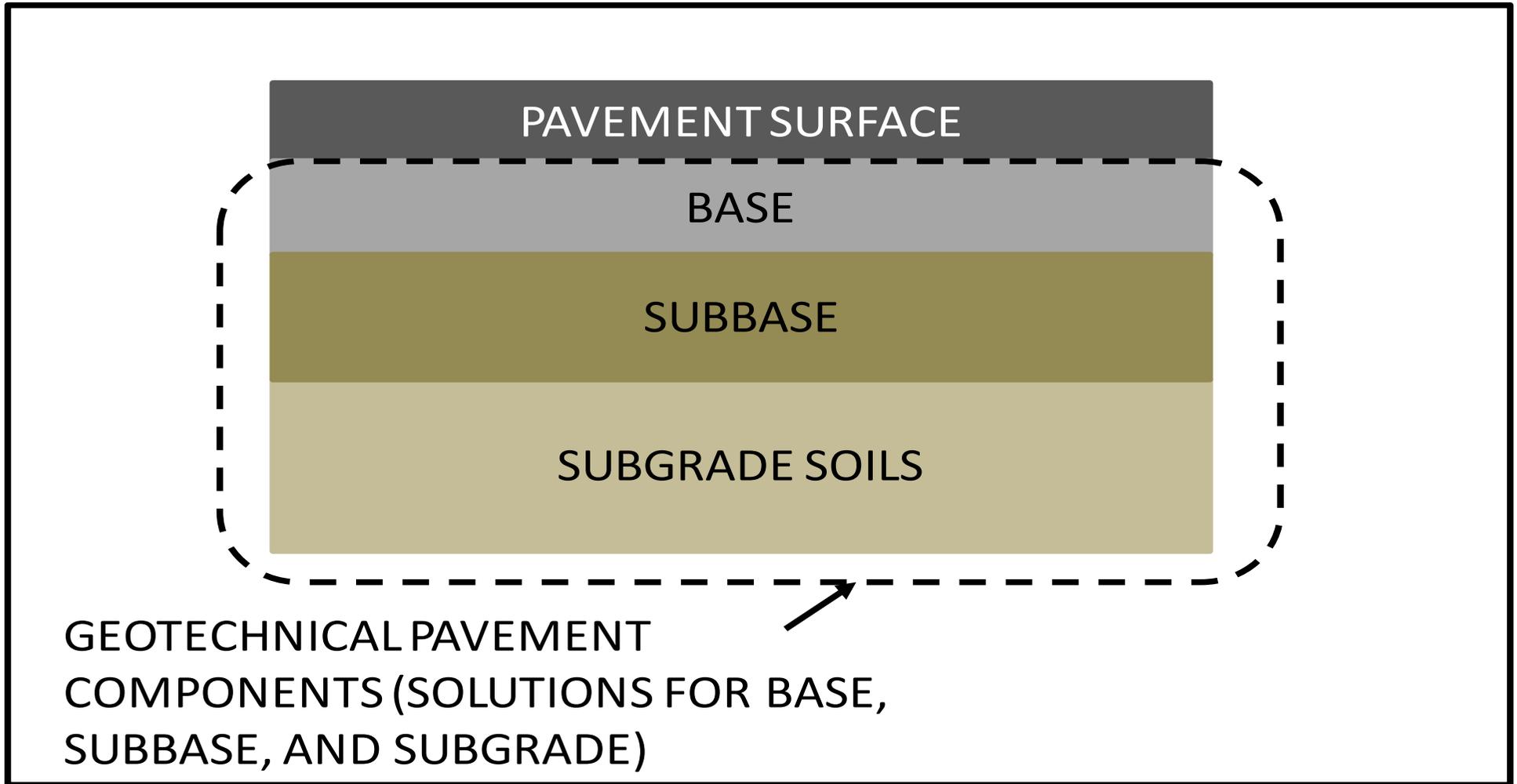
Working Platforms



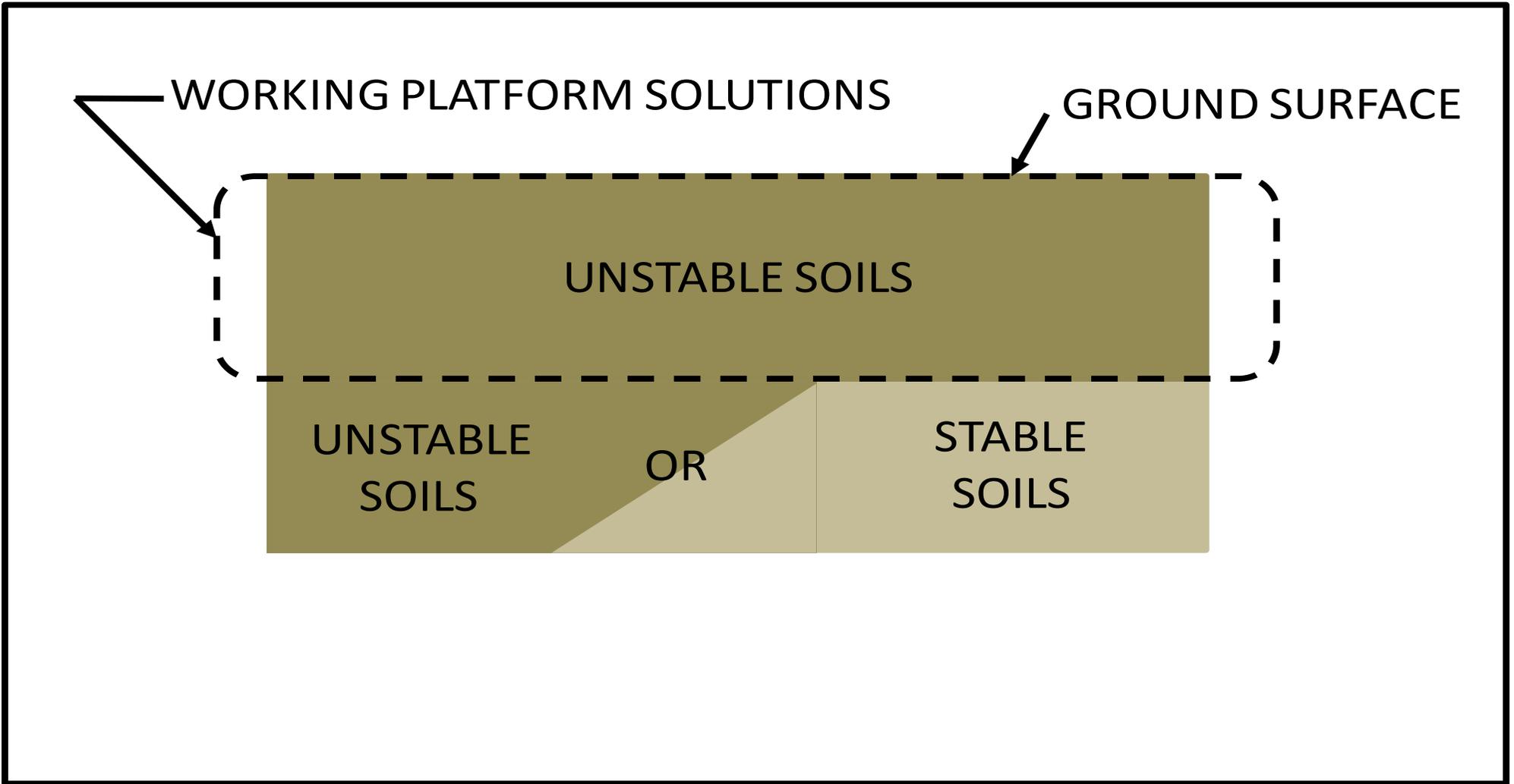
## Construction over Unstable Soils



## Construction over Stable/Stabilized Soils



## Geotechnical Pavement Components (Base, Subbase, and Subgrade)



# Working Platforms



# Information and Guidance System Overview and Examples

<http://www.intrans.iastate.edu/geotechsolutions/index.cfm>

Expected to be open to public in summer 2012

HOME

SHRP 2 R02 PROJECT  
BACKGROUND

GEOTECHNICAL DESIGN  
PROCESS

CATALOG OF  
TECHNOLOGIES

TECHNOLOGY SELECTION

GLOSSARY

ABBREVIATIONS

FREQUENTLY ASKED  
QUESTIONS

SUBMIT A COMMENT

LINKS

ABOUT THIS WEBSITE

## DRAFT - For Beta Review Only

This website and its contents were developed by the SHRP 2 R02 research team and is currently in beta testing; TRB makes no representation or warranty of any kind ([see disclaimer](#)). We look forward to receiving your comments and suggestions.

Geotechnical Solutions for Transportation Infrastructure is a SHRP 2 project developed to make geotechnical solutions more accessible to public agencies in the United States. This website is a toolkit of geotechnical information to address all phases of decision making from planning to design to construction to allow transportation projects to be built faster, to be less expensive, and/or to last longer. Anyone involved in planning, design, and construction of transportation infrastructure will benefit from the information and resources available here.

### Geotechnical Design Process

Prior to technology selection, site-specific conditions and constraints must be identified. The geotechnical design process presents an overview of the considerations involved in evaluating site conditions and implementing a geoconstruction technology.

### Catalog of Technologies

The Catalog of Technologies provides a listing of all the technologies. For each technology, the following information is available:

- Technology Fact Sheet
- Photos
- Case Histories
- Design Guidance
- QC/QA Procedures
- Cost Estimating
- Specifications
- Bibliography

### Technology Selection

Technology Selection is an interactive tool to identify candidate technologies for specific geoconstruction applications using project information and constraints. Final technology selection requires project-specific engineering. Technologies can also be accessed by classification or through a catalog of specific technologies.

### Glossary

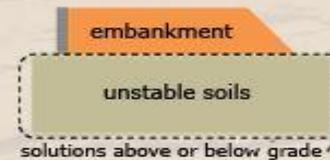
This website contains technical terms and industry-specific jargon. A glossary has been compiled to assist in understanding the terminology used throughout this website and in its documents.

## Interactive Selection System

### Select an Application ?

Begin the interactive selection system by selecting one of the applications to the right. These inputs are the basic information required for screening potential technologies.

The technologies shown in the far right-hand column are all the potential solutions available in this system. After selecting one of the applications below, a short list of potential solutions for the selected application will appear in the right hand column. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.



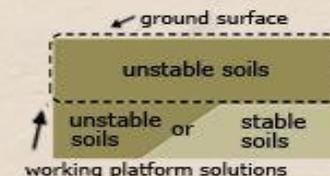
▶ Construction over Unstable Soils



▶ Construction over Stable or Stabilized Soils



▶ Geotechnical Pavement Components (Base, Subbase, and Subgrade)



▶ Working Platforms

? are found throughout the interactive selection system to provide additional information regarding each selection.

## Technologies

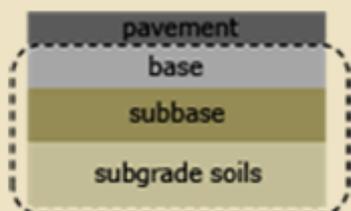
- ▶ Aggregate Columns
- ▶ Beneficial Reuse of Waste Materials
- ▶ Bio-Treatment for Subgrade Stabilization
- ▶ Blasting Densification
- ▶ Bulk-Infill Grouting
- ▶ Chemical Grouting/Injection Systems
- ▶ Chemical Stabilization of Subgrades and Bases
- ▶ Column-Supported Embankments
- ▶ Combined Soil Stabilization with Vertical Columns
- ▶ Compaction Grouting
- ▶ Continuous Flight Auger Piles
- ▶ Deep Dynamic Compaction
- ▶ Deep Mixing Methods
- ▶ Drilled/Grouted and Hollow Bar Soil Nailing
- ▶ Electro-Osmosis
- ▶ Excavation and Replacement
- ▶ Fiber Reinforcement for Slopes
- ▶ Fiber Reinforcement in Pavement Systems
- ▶ Geocell Confinement in Pavement Systems
- ▶ Geosynthetic Reinforced Construction Platforms
- ▶ Geosynthetic Reinforced Embankments

# Technology Selection Application

Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

## Your selections so far

Click on an item to return to a previous selection.



Selected Application: Geotechnical Pavement Components (Base, Subbase, and Subgrade)

## Click on a response that best represents project conditions

### Select Purpose of Technology Application

- ▶ Stabilization of Pavement Support Layer(s)
- ▶ Use of Alternative or Recycled Materials in Pavement Support Layer(s)
- ▶ Void Filling

# Technologies

**Beneficial Reuse of Waste Materials**

**Bio-Treatment for Subgrade Stabilization**

**Bulk-Infill Grouting**

**Chemical Grouting/Injection Systems**

**Chemical Stabilization of Subgrades and Bases**

**Electro-Osmosis**

**Excavation and Replacement**

**Fiber Reinforcement in Pavement Systems**

**Geosynthetic Reinforced Constructive Platforms**

**Geosynthetic Reinforcement in Pavement Systems**

**Geosynthetic Separation in Pavement Systems**

**Geosynthetics in Pavement Drainage**

**Hydraulic Fill + Vacuum Consolidation Geocomposite Drains**

**Injected Lightweight Foam Fill**

**Intelligent Compaction**

**Mechanical Stabilization of Subgrade and Bases**

**Onsite Use of Recycled Pavement Materials**

**Partial Encapsulation**

**Traditional Compaction**

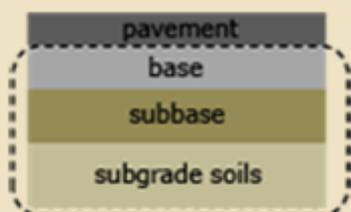
**Vacuum Preloading with and without PVDs**

# Technology Selection Application

Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

## Your selections so far

Click on an item to return to a previous selection.



Selected Application: **Geotechnical Pavement Components (Base, Subbase, and Subgrade)**

> Purpose of Technology Application: **Stabilize Pavement Support Layer(s)**

## Click on a response that best represents project conditions

### Select Pavement Support Layers to Be Improved

- ▶ **Base/Subbase Layer**
- ▶ **Subgrade Layer**
- ▶ **Deeper Subgrade Treatment** (This selection links to the Construction Over Unstable Soils portion of the interactive selection system.)
- ▶ **In-situ Treatment with Pavement Surface In Place**

# Technologies

## Beneficial Reuse of Waste Materials

**Bio-Treatment for Subgrade Stabilization**

**Bulk-Infill Grouting**

**Chemical Grouting/Injection Systems**

**Chemical Stabilization of Subgrades and Bases**

**Electro-Osmosis**

**Excavation and Replacement**

**Fiber Reinforcement in Pavement Systems**

**Geosynthetic Reinforced Constructive Platforms**

**Geosynthetic Reinforcement in Pavement Systems**

**Geosynthetic Separation in Pavement Systems**

**Geosynthetics in Pavement Drainage**

**Hydraulic Fill + Vacuum Consolidation Geocomposite Drains**

**Injected Lightweight Foam Fill**

**Intelligent Compaction**

**Mechanical Stabilization of Subgrade and Bases**

**Onsite Use of Recycled Pavement Materials**

**Partial Encapsulation**

**Traditional Compaction**

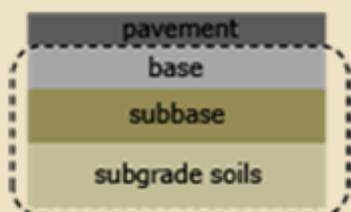
**Vacuum Preloading with and without PVDs**

# Technology Selection Application

Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

## Your selections so far

Click on an item to return to a previous selection.



Selected Application: **Geotechnical Pavement Components (Base, Subbase, and Subgrade)**

> Purpose of Technology Application: **Stabilize Pavement Support Layer(s)**

> Layers to Be Improved: **Subgrade Layer**

## Click on a response that best represents project conditions

### Select Subgrade Soil Type

- > High-plasticity (CH, MH) soils
- > Low-plasticity (CL, ML) soils
- > Plastic sands and gravels (GC, SC)
- > Silty sands and gravels (GM, SM)
- > Clean sands and gravels (SP, SW, GP, GW)
- > Rock fill

# Technologies

Beneficial Reuse of Waste Materials

**Bio-Treatment for Subgrade Stabilization**

Bulk-Infill Grouting

Chemical Grouting/Injection Systems

**Chemical Stabilization of Subgrades and Bases**

Electro-Osmosis

Excavation and Replacement

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**Geosynthetic Reinforcement in Pavement Systems**

**Geosynthetic Separation in Pavement Systems**

**Geosynthetics in Pavement Drainage**

Hydraulic Fill + Vacuum Consolidation  
Geocomposite Drains

Injected Lightweight Foam Fill

**Intelligent Compaction**

**Mechanical Stabilization of Subgrade and Bases**

Onsite Use of Recycled Pavement Materials

**Partial Encapsulation**

**Traditional Compaction**

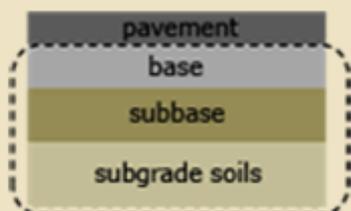
Vacuum Preloading with and without  
DVDs

# Technology Selection Application

Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

## Your selections so far

Click on an item to return to a previous selection.



Selected Application: **Geotechnical Pavement Components (Base, Subbase, and Subgrade)**

- > Purpose of Technology Application: **Stabilize Pavement Support Layer(s)**
- > Layers to Be Improved: **Subgrade Layer**
- > Subgrade Soil Type: **Low-plasticity (CL, ML) soils**

## Click on a response that best represents project conditions

### Select Property for Improvement

- ▶ **Increase strength/stiffness and reduce deformation**
- ▶ **Mitigate moisture/drainage problems**
- ▶ **Increase freeze/thaw durability**

# Technologies

Beneficial Reuse of Waste Materials

**Bio-Treatment for Subgrade Stabilization**

Bulk-Infill Grouting

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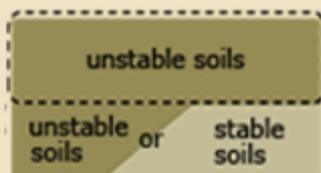
Vacuum Preloading with and without PVDs

# Technology Selection Application

Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

## Your selections so far

Click on an item to return to a previous selection.



Selected Application: Working Platforms

## Click on a response that best represents project conditions

### Select Type of Working Platform

- ▶ Permanent/deformation control
- ▶ Temporary/provide platform to support construction traffic over soft soil
- ▶ Construction platform in areas outside of traffic

# Technologies

**Chemical Stabilization of Subgrades and Bases**

**Excavation and Replacement**

**Geosynthetic Reinforced Constructive Platforms**

**Geosynthetic Reinforcement in Pavement Systems**

**Mechanical Stabilization of Subgrade and Bases**

# Technology

## Prefabricated Vertical Drains and Fill Preloading

The links below open PDFs in a new window. The documents provide information about the selected technology.

- Technology Fact Sheet
- Photos
- Case Histories
- Design Procedures
- Quality Control/Quality Assurance
- Cost Estimating
- Specifications

Clear

Create Zip File

The SHRP2 R02 ratings for this technology are as follows:

Degree of Technology Establishment	Potential Contribution to SHRP2 Renewal Objectives		
	Rapid Renewal of Transp. Facilities	Minimal Disruption of Traffic	Production of Long-Lived Facilities
5	2	1	4

(Rating Scale: 1 = not established or low applicability, 5 = well established or high applicability)

# Technologies

- Aggregate Columns
- Beneficial Reuse of Waste Materials
- Bio-Treatment for Subgrade Stabilization
- Blasting Densification
- Bulk-Infill Grouting
- Chemical Grouting/Injection Systems
- Chemical Stabilization of Subgrades and Bases
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- Deep Mixing Methods
- Drilled/Grouted and Hollow Bar Soil Nailing
- Electro-Osmosis
- Excavation and Replacement
- Fiber Reinforcement for Slopes
- Fiber Reinforcement in Pavement Systems
- Geosynthetic Reinforced Construction Platforms
- Geosynthetic Reinforced Embankments
- Geosynthetic Reinforcement in Pavement Systems
- Geosynthetic Separation in

# **Products Available for each Technology (Information Transfer)**

- **For each technology:**
  - ❖ **Technology Fact Sheet**
  - ❖ **Photographs**
  - ❖ **Case Histories**
  - ❖ **Design Procedures**
  - ❖ **Quality Control/Quality Assurance**
  - ❖ **Cost Estimating**
  - ❖ **Specifications**
  - ❖ **Bibliography**

# Interactive Selection System

Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

## Your selections so far

Click on an item to return to a previous selection.

embankment

Selected Application Construction Over Unstable Soils

unstable soils

## Select a response that best represents project conditions

← return to previous selection

### ? Select Unstable Soil Condition

- ▶ Unsaturated and Saturated, Fine Grained Soil
- ▶ Unsaturated, Loose Granular Soils
- ▶ Saturated, Loose Granular Soils
- ▶ Voids – Sinkholes, Abandoned Mines, etc.
- ▶ Problem Soils and Sites – Expansive, Collapsible, Dispersive, Organic, Existing Fill, Landfills

# Technologies

- ▶ Aggregate Columns
- ▶ Blasting Densification
- ▶ Bulk-Infill Grouting
- ▶ Chemical Grouting/Injection Systems
- ▶ Column-Supported Embankments
- ▶ Combined Soil Stabilization with Vertical Columns
- ▶ Compaction Grouting
- ▶ Continuous Flight Auger Piles
- ▶ Deep Dynamic Compaction
- ▶ Deep Mixing Methods
- ▶ Electro-Osmosis
- ▶ Excavation and Replacement
- ▶ Geosynthetic Reinforced Embankments
- ▶ Geotextile Encased Columns
- ▶ High-Energy Impact Rollers
- ▶ Injected Lightweight Foam Fill
- ▶ Jet Grouting
- ▶ Lightweight Fill, EPS Geofoam, Low-Density Cementitious Fill

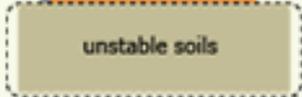
*\*For guidance on combining technologies, see White Paper on [Integrated Technologies for Embankments on Unstable Ground](#).*

# Interactive Selection System

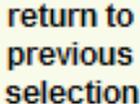
Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

## Your selections so far

Click on an item to return to a previous selection.

		Construction Over Unstable Soils
		Unsaturated and Saturated, Fine Grained Soil

## Select a response that best represents project conditions

		 <b>Depth Below Ground Surface To Which Unstable Soils Extend</b>
		 0 - 5 ft
		 5 - 10 ft
		 10 - 30 ft
		 30 - 50 ft
		 Greater than 50 ft

# Technologies

## ▶ Aggregate Columns

Blasting Densification

Bulk-Infill Grouting

Chemical Grouting/Injection Systems

## ▶ Column-Supported Embankments

## ▶ Combined Soil Stabilization with Vertical Columns

Compaction Grouting

## ▶ Continuous Flight Auger Piles

Deep Dynamic Compaction

## ▶ Deep Mixing Methods

## ▶ Electro-Osmosis

## ▶ Excavation and Replacement

## ▶ Geosynthetic Reinforced Embankments

## ▶ Geotextile Encased Columns

High-Energy Impact Rollers

## ▶ Injected Lightweight Foam Fill

## ▶ Jet Grouting

## ▶ Lightweight Fill, EPS Geofoam, Low-Density Cementitious Fill

## ▶ Micro-Piles

\*For guidance on combining technologies, see *White Paper on Integrated Technologies for Embankments on Unstable Ground*.

# Project-Specific Technology Selection

This will display selections made and the next set of questions.

## Selections Made

The following selections have been made so far. Click on an item to return to a previous selection.

<b>embankment</b>	Selected Application: <b>Construction over unstable soils</b>
<b>unstable soils</b>	Unstable Soil Condition: <b>Unsaturated/Saturated, Fine Grained Soils</b> ▼
Construction over unstable soils	Depth Below Ground Surface: <b>10 - 30 ft</b> ▼

## Select Project-Specific Characteristics

Select unstable soil condition that best describes site:

Are sufficiently thick peat layers present that will affect construction and settlement?

Are water bearing sands present in the soil to be improved?

Would any subsurface obstruction cause drilling difficulty, such as cobbles or boulders?

Purpose of Improvement:

Select Project Type:

Site Characteristics:

Size of Area to be Improved:

Project Constraints:

Create PDF of your selections and results

# Technologies

Aggregate Columns

Blasting Densification

Chemical Grouting/Injection Systems

Column-Supported Embankments

Combined Soil Stabilization with Vertical Columns

Compaction Grouting

Continuous Flight Auger Piles

Deep Dynamic Compaction

Deep Mixing Methods

Electro-Osmosis

Excavation and Replacement

Geosynthetic Reinforced Embankments

Geotextile Encased Columns

High-Energy Impact Rollers

Injected Lightweight Foam Fill

Jet Grouting

Lightweight Fills

Micro-Piles

Prefabricated Vertical Drains and Fill Preloading

Rapid Impact Compaction

Sand Compaction Piles

Vacuum Preloading with and without Prefabricated Vertical Drains

Vibrocompaction

Vibro-Concrete Columns

# Project-Specific Technology Selection

This will display selections made and the next set of questions.

## Selections Made

The following selections have been made so far. Click on an item to return to a previous selection.

<b>embankment</b>	Selected Application: <b>Construction over unstable soils</b>
<b>unstable soils</b>	Unstable Soil Condition: <b>Unsaturated/Saturated, Fine Grained Soils</b> ▼
Construction over unstable soils	Depth Below Ground Surface: <b>30 - 50 ft</b> ▼

## Select Project-Specific Characteristics

Select unstable soil condition that best describes site:	<b>Unstable soil extends from surface to treatment dep</b> ▼
Are sufficiently thick peat layers present that will affect construction and settlement?	<b>No</b> ▼
Are water bearing sands present in the soil to be improved?	<b>No</b> ▼
Would any subsurface obstruction cause drilling difficulty, such as cobbles or boulders?	----- <b>Make your selection</b> ----- ▼
Purpose of Improvement:	<b>Increase Strength</b> ▼
Select Project Type:	<b>Embankment Widening</b> ▼
Site Characteristics:	<b>Constrained, developed sites</b> ▼
Size of Area to be Improved:	<b>From 10,000 ft<sup>2</sup> (930 m<sup>2</sup>) to 50,000 ft<sup>2</sup> (4,600 m<sup>2</sup>)</b> ▼
Project Constraints:	----- <b>Make your selection</b> ----- ▼

[Create PDF of your selections and results](#)

# Technologies

## Aggregate Columns

- Blasting Densification
- Chemical Grouting/Injection Systems
- Column-Supported Embankments

## Combined Soil Stabilization with Vertical Columns

- Compaction Grouting
- Continuous Flight Auger Piles
- Deep Dynamic Compaction

## Deep Mixing Methods

### Electro-Osmosis

- Excavation and Replacement
- Geosynthetic Reinforced Embankments
- Geotextile Encased Columns
- High-Energy Impact Rollers
- Injected Lightweight Foam Fill

## Jet Grouting

- Lightweight Fills
- Micro-Piles

## Prefabricated Vertical Drains and Fill Preloading

- Rapid Impact Compaction

## Sand Compaction Piles

## Vacuum Preloading with and without Prefabricated Vertical Drains

- Vibrocompaction
- Vibro-Concrete Columns

# Technology

## Aggregate Columns

The links below open PDFs in a new window. The documents provide information about the selected technology.

[Technology Fact Sheet](#)

[Photos](#)

[Case Histories](#)

[Design Procedures](#)

[Quality Control/Quality Assurance](#)

[Cost Estimating](#)

[Specifications](#)

The SHRP2 R02 ratings for this technology are as follows:

Degree of Technology Establishment	Potential Contribution to SHRP2 Renewal Objectives		
	Rapid Renewal of Transp. Facilities	Minimal Disruption of Traffic	Production of Long-Lived Facilities
4	4	1	4

(Rating Scale: 1 = not established or low applicability, 5 = well established or high applicability)

# Technologies

## Aggregate Columns

[Beneficial Reuse of Waste Materials](#)

[Bio-Treatment for Subgrade Stabilization](#)

[Blasting Densification](#)

[Bulk-Infill Grouting](#)

[Chemical Grouting/Injection Systems](#)

[Chemical Stabilization of Subgrades and Bases](#)

[Column-Supported Embankments](#)

[Combined Soil Stabilization with Vertical Columns](#)

[Continuous Flight Auger Piles](#)

[Deep Dynamic Compaction](#)

[Deep Mixing Methods](#)

[Drilled/Grouted and Hollow Bar Soil Nailing](#)

[Electro-Osmosis](#)

[Excavation and Replacement](#)

[Fiber Reinforcement for Slopes](#)

[Fiber Reinforcement in Pavement Systems](#)

# Technology

## Prefabricated Vertical Drains and Fill Preloading

The links below open PDFs in a new window. The documents provide information about the selected technology.

- Technology Fact Sheet
- Photos
- Case Histories
- Design Procedures
- Quality Control/Quality Assurance
- Cost Estimating
- Specifications

Clear

Create Zip File

The SHRP2 R02 ratings for this technology are as follows:

Degree of Technology Establishment	Potential Contribution to SHRP2 Renewal Objectives		
	Rapid Renewal of Transp. Facilities	Minimal Disruption of Traffic	Production of Long-Lived Facilities
5	2	1	4

(Rating Scale: 1 = not established or low applicability, 5 = well established or high applicability)

# Technologies

- Aggregate Columns
- Beneficial Reuse of Waste Materials
- Bio-Treatment for Subgrade Stabilization
- Blasting Densification
- Bulk-Infill Grouting
- Chemical Grouting/Injection Systems
- Chemical Stabilization of Subgrades and Bases
- Column-Supported Embankments
- Combined Soil Stabilization with Vertical Columns
- Compaction Grouting
- Continuous Flight Auger Piles
- Deep Dynamic Compaction
- Deep Mixing Methods
- Drilled/Grouted and Hollow Bar Soil Nailing
- Electro-Osmosis
- Excavation and Replacement
- Fiber Reinforcement for Slopes
- Fiber Reinforcement in Pavement Systems
- Geosynthetic Reinforced Construction Platforms
- Geosynthetic Reinforced Embankments
- Geosynthetic Reinforcement in Pavement Systems
- Geosynthetic Separation in

HOME

SHRP 2 R02 PROJECT  
BACKGROUND

GEOTECHNICAL DESIGN  
PROCESS

CATALOG OF  
TECHNOLOGIES

TECHNOLOGY SELECTION

GLOSSARY

ABBREVIATIONS

FREQUENTLY ASKED  
QUESTIONS

SUBMIT A COMMENT

LINKS

ABOUT THIS WEBSITE

## Submit a Comment

Use the form below to submit a comment regarding this website to the project team. For inquiries regarding submission of technology specific information, please see the Frequently Asked Questions below:

### FAQs

[How do I submit a case history for a technology?](#)

[How do I submit a photograph or video for a technology?](#)

[How do I submit a specification for a technology?](#)

[How do I submit cost information for a technology?](#)

[How do I submit a reference for a technology?](#)

→ [To submit documents, go to the Submit Technology-Specific Information page.](#)

Fields marked with \* are required.

\*Name:

\*E-mail address:

\*Reconfirm E-Mail:

\*Technology:

\*Comment regarding:

\*Comment:

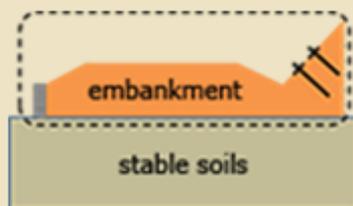
Submit Comment

# Technology Selection Application

Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

## Your selections so far

Click on an item to return to a previous selection.



Selected Application: **Construction Over Stable or Stabilized Soils**

## Click on a response that best represents project conditions

### Select Purpose of Technology Application

- ▶ Enhance Compaction Process
- ▶ Slope Stabilization and Earth Retention
- ▶ Use of Alternative or Recycled Materials

# Technologies

- Beneficial Reuse of Waste Materials**
- Drilled/Grouted and Hollow Bar Soil Nailing**
- Fiber Reinforcement for Slopes**
- High-Energy Impact Rollers**
- Hydraulic Fill + Vacuum Consolidation**
- Geocomposite Drains**
- Intelligent Compaction**
- Lightweight Fill, EPS Geofoam, Low-Density Cementitious Fill**
- MSEW**
- Onsite Use of Recycled Pavement Materials**
- Rapid Impact Compaction**
- Reinforced Soil Slopes**
- Screw-in Soil Nailing**
- Shoot-in Soil Nailing**
- Shored Mechanically Stabilized Earth Wall System**
- Traditional Compaction**