Highway Renewal Products from SHRP 2

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The Demand:

RENEWING the network
+
MINIMIZING DISRUPTION to society
Producing Tools to
GET IN
GET OUT
STAY OUT
FASTER
geotechnical
in situ
construction
Design Procedures
Catalog of materials for ground improvement
Methods for estimating costs
Guidelines for QA/QC
Welcome

Geotechnical Solutions for Transportation Infrastructure is a SHRP-2 project developed to make geotechnical solutions more accessible to public agencies in the United States for rapid renewal and improvement of the nation's transportation infrastructure.

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. Specific information for various geosynthesis and ground improvement technologies can be found in the Catalog of Technologies.

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 Procedures
- QC/QA Procedures
- Cost Estimating
- Specifications
- Bibliography

Technology Selection

Technology Selection is an interactive tool to identify candidate technologies for specific geosynthesis 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.

Abbreviations and Glossary

This website contains technical terms and industry specific jargon. A listing of abbreviations has been tabulated and a glossary has been compiled to assist in understanding the terminology used throughout this website and 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.

- Embankment
  - Unstable Soils
    - Solutions above or below grade
  - Stable Soils
    - Construction Over Unstable Soils

- Embankment
  - Solutions above grade
  - Construction Over Stable or Stabilized Soils

- Pavement Base
  - Subbase
  - Subgrade Soils
  - Geotechnical Pavement Components (Base, Subbase, and Subgrade)

- Ground Surface
  - Unstable Soils
    - Working Platforms

- Working Platform Solutions

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 Compaction
- Drilled/Grouted and Hollow Bar Soil Nailing
- Electro-Osmosis
- Excavation and Replacement
- Fiber Reinforcement for Slopes
- Fiber Reinforcement in Pavement Systems
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
- Unstable Soils
- Selected Application: Construction Over Unstable Soils

**Select a response that best represents project conditions**

- 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

*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.

- embankment
- unstable soils

Selected Application: Construction Over Unstable Soils
Unstable Soil Condition: Unsaturated and Saturated, Fine Grained Soil

Select a response that best represents project conditions

Depth Below Ground Surface To Which Unstable Soils Extend

- 0 - 5 ft
- 5 - 10 ft
- 10 - 30 ft
- 30 - 50 ft
- Greater than 50 ft

*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.

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

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 withoutPrefabricated 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.

Selected Application: Construction over unstable soils

Unstable Soil Condition: Unsaturated/Saturated, Fine Grained Soils

Depth Below Ground Surface: 30 - 50 ft

Select Project-Specific Characteristics

Select unstable soil condition that best describes site:

Unstable soil extends from surface to treatment dep

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

No

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

No

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

Make your selection

Purpose of Improvement:

Increase Strength

Select Project Type:

Embankment Widening

Site Characteristics:

Constrained, developed sites

Size of Area to be Improved:

From 10,000 ft² (930 m²) to 50,000 ft² (4,600 m²)

Project Constraints:

Make your selection

Create PDF of your selections and results

Technologies

Aggregate Columns
Blasting Densification
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Jet Grouting
Lightweight Fills
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Prefabricated Vertical Drains and Fill Preloading
Rapid Impact Compaction
Sand Compaction Piles
Vacuum Preloading with and without Prefabricated Vertical Drains
Vibrocompaction
Vibro-Concrete Columns
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

The SHRP2 R02 ratings for this technology are as follows:

<table>
<thead>
<tr>
<th>Degree of Technology Establishment</th>
<th>Potential Contribution to SHRP2 Renewal Objectives</th>
</tr>
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<tbody>
<tr>
<td>5</td>
<td>Rapid Renewal of Transp. Facilities</td>
</tr>
<tr>
<td></td>
<td>Minimal Disruption of Traffic</td>
</tr>
<tr>
<td></td>
<td>Production of Long-Lived Facilities</td>
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<tr>
<td></td>
<td>2</td>
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<td>1</td>
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<td>4</td>
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</tbody>
</table>

(Rating Scale: 1 = not established or low applicability, 5 = well established or high applicability)
A-1 (Group, AASHTO classification) - The typical material of this group is a well-graded mixture of stone fragments or gravel, coarse sand, fine sand, and a nonplastic or feebly plastic soil binder. However, this group also includes stone fragments, gravel, coarse sand, volcanic cinders, etc. without soil binder. (AASHTO M 145-91)

A-1-a (Subgroup, AASHTO classification) - includes those materials consisting predominantly of stone fragments or gravel, either with or without a well-graded binder of finer material. (AASHTO M 145-91)

A-1-b (Subgroup, AASHTO classification) - includes those materials consisting predominantly of coarse sand either with or without a well-graded soil binder. (AASHTO M 145-91)

A-2 (Group, AASHTO classification) - This group includes a wide variety of "granular" materials which are borderline between the materials falling in Groups A-1 and A-3 and silt-clay materials of Groups A-4, A-5, A-6 and A-7. It includes all materials containing 35 percent or less passing the 75-μm (No. 200) sieve which cannot be classified as A-1 or A-3, due to fines content or plasticity or both, in excess of the limitations for those groups. (AASHTO M 145-91)

A-2-4 and A-2-5 (Subgroups, AASHTO classification) - include various granular materials containing 35 percent or less passing the 75-μm (No. 200) sieve and with a minus 0.425-mm (No. 40) portion having the characteristic of the A-4 and A-5 groups. These groups include such materials as gravel and coarse and with silt contents or plasticity indexes in excess of the limitations of Group A-I, and fine and with nonplastic silt content in excess of the limitations of Group A-3. (AASHTO M 145-91)

A-2-6 and A-2-7 (Subgroups, AASHTO classification) - include materials similar to those described under Subgroups A-2-4 and A-2-5 except that the fine portion contains plastic clay having the characteristics of the A-6 or A-7 group. Classification of materials in the various groups
FASTER in-situ inspections
Getting what was specified?
Field evaluation of materials
Pavement Durability

Initial Observations

Premature Failure
During/After Compaction GPR Testing
Real-Time Infrared Measurements
Real-Time Smoothness Measurements
Device 1: GOMACO Smoothness Indicator (GSI)
Device 2: Ames Engineering Real Time Profiler (RTP)
Independent validation of NDT techniques
DATA PRESENTATION

Introduction

Data are typically presented by defining the deterioration boundaries or by defining areas of different degrees of deterioration progression. The first one is illustrated in Figure 2, where the areas marked in red represent the areas of severe deterioration. The second one is illustrated in Figure 3, where the four grades correspond to the description provided in the physical principle of transition.

Figure 2. Identified areas of severe deterioration (API Corporation)

Impact Echo (Stepper) - Condition Rating
Preserving high-volume roads
Typical Pavement Lifecycle

Pavement Condition

- Good
- Poor

Preservation

Rehabilitation

Minor

Major

Reconstruction

Time (years)
Guidelines on **pavement strategies** for preservation for high-traffic volume roads
Detailed information on the state of the practice
Comprehensive treatment selection framework/process
Guidelines for the Preservation of High-Traffic-Volume Roadways
Using existing in-place pavement
Guidelines to identify best set of potential treatments
Decision-support tools
Details for integrating renewed pavements with adjacent pavements / structures
Pavement Assessment

Broadly, pavement assessment involves an examination of the existing roadway. Data is collected and analyzed to determine the characteristics and condition of the existing structure. This information is then plotted versus longitudinal distance along the lane. Based on critical areas of distress and other structural factors, the length of the project is typically divided into smaller homogenous sections. Once the roadway is sectioned using the process above, a subset of “critical sections” is selected that will dominant the overall renewal process. From this set of critical sections, a primary candidate section is selected to perform extended analysis to determine the appropriate renewal strategy.

For renewal section design, the critical section is examined in detail using cross section and distress information to produce a recommended design strategy. This step also takes into account any external factors the design should be considered including...
Long Lived Facilities: Rehabilitation Strategies to Produce Long Life Pavements

1. Specify existing and proposed section info
2. Specify existing pavement condition
3. Confirm section design parameters
4. Select renewal strategy
5. Recommended section, best practices
Step 1. Enter Section Information

General Description information
Step 1. Existing Section

What is the existing pavement structure?
Step 1. Proposed Section

What is the design information for the proposed pavement structure?
Step 2. Enter Pavement Condition

Distresses are unique for rigid, flexible and composite pavements
Rigid: Identify Distresses Present

Graphics to aid user in determination
Step 3. Confirm Section Condition

Must confirm the information
Step 4. Select Renewal Type

Select either a flexible and rigid renewal option.
Step 5. Recommendation Summary

Links to supporting documents and materials
Step 5. Resources

Click Resource Tab to access more information.
RENEWING the network + MINIMIZING DISRUPTION to society
Get In
Get Out
and
Stay Out
Implementation is where the rubber will meet the road.
SHRP 2
to meet the demands of tomorrow’s highway renewal