GeoTechTools
Engineering Tools & Technology Selection Guidance for Geotechnical & Structural Engineers

Partnerships for Progress in Transportation

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www.GeoTechTools.org

A Comprehensive Web-Based Information & Guidance System for Embankment, Ground Improvement & Pavement Applications

SHRP 2 Project R02: Geotechnical Solutions for Transportation Infrastructure
Project R02: Geotechnical Solutions for Transportation Infrastructure

Soil Improvement, Rapid Embankment Construction, and Stabilization of the Working Platform
To make geotechnical solutions more accessible to public agencies in the U.S. for rapid renewal and improvement of the transportation infrastructure.

“Project Vision”
www.GeoTechTools.org

makes geotechnical solutions more accessible to public agencies and private firms in the U.S. and worldwide for rapid renewal and improvement of the transportation infrastructure.
APPLICATIONS

SOLUTIONS AT OR BELOW GRADE

EMBANKMENT

UNSTABLE SOILS

SOLUTIONS ABOVE GRADE

EMBANKMENT

STABLE SOILS

PAVEMENT SURFACE

BASE

SUBBASE

SUBGRADE SOILS

SOLUTIONS FOR GEOTECHNICAL
PAVEMENT COMPONENTS (BASE, SUBBASE, AND
SUBGRADE) AND WORKING PLATFORMS

GROUND SURFACE

UNSTABLE SOILS

OR

STABLE SOILS

WORKING PLATFORM SOLUTIONS
R02 Project “Products” or “Tools” Contained in a System on

www.GeoTechTools.org
OBJECTIVES OF THE SYSTEM

1. Identify potential technologies for the four Applications. → 46 Technologies
2. Provide current, up to-date information → 8 Products for each Technology
3. Provide guidance to develop a 'short-list' of applicable technologies
4. Provide guidance for project-specific screening
5. Provide an interactive, programmed system
46 Technologies
VALUE ADDED

The system *collects, synthesizes, integrates, and organizes* a vast amount of *critically important information* about geotechnical solutions on a *readily accessible* website.
Geotech Tools: Geo-construction Information & Technology Selection Guidance for Geotechnical, Structural, & Pavement Engineers was developed by a SHRP 2 project with the goal of making 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. Transportation projects can be designed to be built faster, to be less expensive, and/or to last longer with use of these tools. Anyone involved in planning, design, and construction of transportation infrastructure will benefit from the information and resources available here. The information in the system is also applicable to non-transportation works and beyond the United States. We invite your comments and feedback on any aspect of the system. A Users’ Guide to the Information and Guidance System is available. First time users are encouraged to review the User’s Guide.

**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 geosconstruction 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 its documents.

**Release 1.0**

This website and its contents were developed by the SHRP 2 R02 research team. The system is currently in its first release. The applications, information resources, and referenced numerical values were current at the time of the release (November 2012). Continuous updates to the system based on technology developments and research, user comments, and submitted case histories will be made. TRB and the research team make no representation or warranty of any kind (see disclaimers).
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.

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

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

- **Select Unstable Soil Condition**
  - Wet and Weak, Fine Grained Soils
  - 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*

FAQs are found throughout the interactive selection system to provide additional information regarding each selection.
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
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstable Soils</td>
<td>Unstable Soil Condition</td>
<td>Wet and Weak, Fine Grained Soils</td>
</tr>
</tbody>
</table>

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

- Depth below ground surface requiring treatment. This depth could be full-depth treatment of unstable soils or partial-depth treatment of unstable soils.

- 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.

Tips are found throughout the interactive selection system to provide additional information regarding each selection.
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: Wet and Weak, Fine Grained Soils
- Depth Below Ground Surface: 30 - 50 ft

Select a response that best represents project conditions

This completes the screening process. The highlighted technologies on the right are the candidate technologies based on these selected inputs.

- return to previous selection
- Go to selection summary
- Only proceed to project specific selection if you are experienced with selecting and implementing geotechnology.
- Continue to project-specific selection

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

? are found throughout the interactive selection system to provide additional information regarding each selection.
Interactive Selection System:
Project-Specific Technology Selection for Construction over Unstable Soils

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: Wet and Weak, Fine Grained Soils
  - Depth Below Ground Surface: 30 - 50 ft

Select Project-Specific Characteristics
Answer the following questions that best describe the site conditions. Leave questions blank when the information is unknown (at this time) or inapplicable. The list on the right will update as selections are made. Click on the + for additional information regarding each selection.

1. Purpose of Improvement:
   - Make your selection

2. Additional Purpose of Improvement:
   - Make your selection

3. Select Project Type:
   - Make your selection

4. Site Characteristics:
   - Make your selection

5. Size of Area to be Improved:
   - Make your selection

6. Project Constraint:
   - Make your selection

7. Additional Project Constraint:
   - Make your selection
Interactive Selection System:
Project-Specific Technology Selection for Construction over Unstable Soils

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: Wet and Weak, Fine Grained Soils
Depth Below Ground Surface: 30 – 50 ft.

Select Project-Specific Characteristics
Answer the following questions that best describe the site conditions. Leave questions blank when the information is unknown (at this time) or inapplicable. This list on the right will update as selections are made. Click on the ? for additional information regarding each selection.

- Purpose of Improvement:
  - Bypass Soft Ground

- Additional Purpose of Improvement:
  - Make your selection

- Select Project Type:
  - New Embankment/New Construction

- Site Characteristics:
  - Large, open, undeveloped sites

- Size of Area to Be Improved:
  - Greater than 50,000 ft² (m²)

- Project Constraint:
  - Make your selection

- Additional Project Constraint:
  - Make your selection
Technology Information

Column-Supported Embankments

Columns of strong material are placed in soft ground to provide the necessary support to overlying embankments by transferring the embankment load to a firm stratum. A load transfer platform is used at the base of the embankment to span the space between columns. Total settlement is reduced and stability of the embankment is improved through the use of CSEs. This technique is applicable to new embankments over unstable soils and roadway widening.

- Technology Fact Sheet
- Photos
- Case Histories
  - Highway 241 Wisening, St. Michael, Minnesota
  - Railroad Bridge, Trenton, New Jersey
- Design Guidance
- Quality Control/Quality Assurance
- Cost Information
- Specifications
- Bibliography

Checking multiple documents:

Check the individual boxes beside documents or use the “Check All” button to select the documents for download. After checking the desired documents, select the “Download Zip File” button at left to download your documents.

Special note for column-supported embankments:

See the Column Selection Tool for Column Supported Embankments for assistance in selection column type.

SHRP 2 ratings for Column-Supported Embankments

<table>
<thead>
<tr>
<th>Potential Contribution to SHRP 2 Renewal Objectives</th>
<th>Degree of Technology Establishment</th>
<th>Rapid Renewal of Transp. Facilities</th>
<th>Minimal Disruption of Traffic</th>
<th>Production of Long-Lived Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

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

See the SHRP 2 R02 Technology Ratings Summary for a legend and description of rating.
COLUMN-SUPPORTED EMBANKMENTS

Technology Fact Sheet
November 2012

Basic Function
Column-Supported Embankments (CSE) enable construction of embankments over unstable soils by transferring the load to a stiffer underlying stratum.

Advantages:
- Accelerates construction compared to conventional methods
- Reduces total and differential settlement
- Protects adjacent facilities from distress
- Can be used with a wide variety of columns to accommodate different site conditions

Geologic Applicability:
- Typically used on soft compressible clay, peats, and organic soils where settlement and global stability are concerns
- Most cost effective when the compressible material thickness ranges from 15 to 70 feet (4.6 to 21.3 meters)
- Soft soil underlain by stiffer soil or bedrock

General Description:
Column-supported embankments are used when the soil is too soft or compressible to support the embankment. The columns transfer the load to a firm stratum below the soft layer. The columns can be floating or end-bearing depending on the site geology, the project requirements, and the type of column used. For most CSE applications, the columns are end-bearing. When high-capacity columns with wide spacings are used, geosynthetic reinforcement is typically used at the interface between the top of the columns and the embankment to more efficiently transfer the embankment load to the columns.

Construction Methods:
Columns of strong material are placed in the soft ground to provide the necessary support by transferring the embankment load to a firm stratum. There are numerous types of columns that may be used for this technology (e.g., aggregate columns, vibro-concrete columns, deep mixing method columns, continuous flight auger piles, driven piles with or without pile caps). A load transfer platform or bridging layer may be constructed immediately above the columns to help transfer the load from the embankment to the columns; and thereby permit larger spacing between columns than would be possible otherwise. Load transfer platforms generally consist of compacted soil and geosynthetic reinforcement. The important details of soil type and geosynthetic reinforcement used in the load transfer platform depend on the design procedure employed. Load transfer platforms are used more often when the spacing between columns is relatively large (i.e., greater than 5 feet), which requires higher load carrying capacity from the columns (e.g., vibro-concrete columns, continuous flight auger piles).

Additional Information:
Load transfer platforms are also used to minimize differential settlement when the embankment height is low. Aggregate columns, because of their lower vertical load capacity, are often spaced close enough together that a load transfer platform is not required.

SHRP2 Applications:
- Embankment and roadway construction over unstable soils
- Roadway and embankment widening

Example Successful Applications:
- Rancocas Creek Railroad Bridge – NJ
- I-95/Route 1 Interchange – Alexandria, VA
- Minnesota TH-241 Widening – St. Michael, MN

Complementary Technologies:
Many different column technologies can be used with CSEs. Some applications may use lightweight fill in combination with column supported embankments.

Alternate Technologies:
Technologies for similar applications include preloading with or without PVDs, lightweight fill, excavation and replacement, staged construction, and geosynthetic reinforcement embankments.

Potential Disadvantages:
CSEs can incur a higher cost than technologies that require more time before the embankment can be put into service. CSEs suffer from a lack of standard design procedures and lack of knowledge about technology benefits, design procedures, and construction techniques.

Key References for this Fact Sheet:
COLUMN SUPPORTED EMBANKMENT
MINNESOTA TRUNK HIGHWAY 241 WIDENING
- PROJECT CASE HISTORY -

Location: TH 241 near St. Michael, MN, southwest of I-94/TH 241 interchange

Owner: Minnesota Department of Transportation

Contractor: Mn/DOT and The Collin Group

Engineers: Mn/DOT and The Collin Group

Year Constructed: 2006

Project Summary/Scope:
A pile supported embankment was constructed on Trunk Highway (TH) 241 near St. Michael, MN, about 2,000 feet southwest of the I-94/TH 241 interchange. This project involved the widening of a highway from two to four lanes. The new embankment was a widening of an existing embankment. Differential settlement between the new embankment section and the old section was a concern.

Subsurface Conditions: 30 feet of highly organic silt loams and peats underlain by 20 feet of silty organic soils. Below that is 12 feet of loamy sand underlain by 35 feet of gravely sand. A well-cemented sandstone lay 100 feet below the ground surface. The section of highway is bordered on the northwest by a small pond and on the southeast by marshy terrain.

Pile spacing was 7 feet on-center and the diameter of pile caps was 2 feet. The Load Transfer Platform (LTP) embankment was designed using the beam design method. Piles consisted of steel pipes filled with concrete. Four layers of geosynthetic reinforcement were used with granular fill. The total thickness of the LTP was 3 feet (~1 meter). Backfilling of the embankment was completed on October 10, 2006. Instrumentation data is presented through June 4, 2007.

Complementary Technologies Used:
Gissofoam lightweight fill, reinforced soil slope, and geosynthetic construction platform stabilization technologies were also used for this embankment widening.

Performance Monitoring:
The embankment was instrumented with 48 sensors including strain gages, earth pressure cells, and settlement systems. Settlements, geosynthetic strains, and pile strains/loads are presented in the technical paper for an approximately 18-month period following construction. A finite element analysis was performed using STRAND7. Instrumentation results are compared with the finite element analysis.

Case History
Author/Submitter:
Rich Lamb, P.E.
Foundations Engineer
Mn/DOT Office of Materials
Mailstop 645
1400 Gervais Avenue
Maplewood, MN 55109

Project Technical Paper: 

Date Case History Prepared: November 2012
COLUMN-SUPPORTED EMBANKMENTS (CSE) (Load Transfer Platform (LTP))

COST INFORMATION

Commentary

Because the scope of this technology is limited to the load transfer platform, cost information on column supported embankments is identical to geosynthetic reinforced embankments. Information regarding columns that may be used in conjunction with a column supported embankment is provided separately under the following technologies:

- Continuous flight auger piles
- Deep mixing methods
- Geosynthetic encased columns
- Micropiles
- Aggregate columns
- Vibro-concrete columns

Cost Information Summary

Production rates for the installation of geosynthetic reinforced load transfer platforms are highly sensitive to the delivery rate of granular material. Equipment and labor resources are easily adjusted to match the delivery rate of granular material. Information is provided on two categories of geosynthetics: first, those that are used for the load transfer platform, and second, geosynthetics that are used solely to provide a working platform for a subsequent ground improvement technology. The following table lists construction cost items associated with geosynthetic reinforced load transfer platforms used in column supported embankments, along with approximate cost ranges. Cost ranges are based on data from 2005 through 2010. Readers should carefully examine the project characteristics and constraints and determine to what degree if any these factors may influence the actual cost associated with constructing geosynthetic reinforced embankments.

<table>
<thead>
<tr>
<th>Pay Item Description</th>
<th>Quantity Range</th>
<th>Unit</th>
<th>Low Unit Price</th>
<th>High Unit Price</th>
<th>Factors Which May Potentially Impact Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geosynthetics Used for Load Transfer Platform</td>
<td>Greater Than 5,000</td>
<td>SY</td>
<td>$2.50</td>
<td>$12.00</td>
<td>Geogrids are more expensive than fabrics; Woven fabrics are more expensive than nonwoven fabrics; Heavier fabrics cost more.</td>
</tr>
<tr>
<td>Geosynthetics Used for Working Platforms</td>
<td>Greater Than 5,000</td>
<td>SY</td>
<td>$1.00</td>
<td>$3.50</td>
<td>Same as above.</td>
</tr>
<tr>
<td>Granular Fill Material</td>
<td>Greater Than 2,500</td>
<td>TON</td>
<td>$7.00</td>
<td>$20.00</td>
<td>Material specifications and haul distance will impact unit costs; Haul route conditions will impact unit costs.</td>
</tr>
</tbody>
</table>

Historical Cost Information

A sample of actual project costs for geosynthetics used as reinforcement is shown in the table below.

<table>
<thead>
<tr>
<th>Pay Item Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Low Unit Price</th>
<th>High Unit Price</th>
<th>Average Unit Price</th>
<th>No. of Bids</th>
<th>Bid Date</th>
<th>Source/Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geosynthetic Reinforcement, Fill, Over Soft Soils</td>
<td>4,835</td>
<td>SY</td>
<td>$3.13</td>
<td>n/a</td>
<td>n/a</td>
<td>1</td>
<td>3/4/2009</td>
<td>Florida DOT</td>
</tr>
<tr>
<td>Miscellaneous Geogrid Reinforcement, Type 1</td>
<td>8,375</td>
<td>SY</td>
<td>$2.70</td>
<td>$5.60</td>
<td>$4.19</td>
<td>7</td>
<td>4/23/2009</td>
<td>Oregon DOT</td>
</tr>
</tbody>
</table>
COLUMN-SUPPORTED EMBANKMENTS (CSE)
(LOAD TRANSFER PLATFORM (LTP))

COST INFORMATION

A sample of actual project costs for geosynthetics used in working platforms is shown in the table below.

<table>
<thead>
<tr>
<th>Pay Item Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Low Unit Price</th>
<th>High Unit Price</th>
<th>Average Unit Price</th>
<th>No. of Bids</th>
<th>Bid Date</th>
<th>Source/Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcement Grid (Bioclastic, Type 2)</td>
<td>90,023</td>
<td>SY</td>
<td>$2.53</td>
<td>n/a</td>
<td>$1.79</td>
<td>1</td>
<td>7/29/2009</td>
<td>Florida DOT</td>
</tr>
<tr>
<td>Geogrid Base Reinforcement</td>
<td>72,000</td>
<td>SY</td>
<td>$1.00</td>
<td>$2.40</td>
<td>$1.79</td>
<td>10</td>
<td>6/5/2009</td>
<td>Arizona DOT</td>
</tr>
<tr>
<td>Geobale Reinforcement</td>
<td>28,100</td>
<td>SY</td>
<td>$1.75</td>
<td>$3.25</td>
<td>$2.21</td>
<td>9</td>
<td>6/12/2009</td>
<td>Arizona DOT</td>
</tr>
<tr>
<td>Stabilization Geotextile, Special</td>
<td>5,735</td>
<td>SY</td>
<td>$1.60</td>
<td>$3.50</td>
<td>$2.22</td>
<td>6</td>
<td>9/25/2009</td>
<td>Arizona DOT</td>
</tr>
<tr>
<td>Geotextile Stabilization</td>
<td>12,320</td>
<td>SY</td>
<td>$1.46</td>
<td>$4.80</td>
<td>$2.55</td>
<td>12</td>
<td>3/5/2010</td>
<td>Michigan DOT</td>
</tr>
<tr>
<td>Geotextile Stabilization</td>
<td>3,210</td>
<td>SY</td>
<td>$2.45</td>
<td>$3.25</td>
<td>$2.65</td>
<td>4</td>
<td>10/1/2010</td>
<td>Michigan DOT</td>
</tr>
<tr>
<td>Special – Geogrid, Type P2 (WT.05)</td>
<td>32,367</td>
<td>SY</td>
<td>$0.84</td>
<td>$1.46</td>
<td>$1.15</td>
<td>6</td>
<td>3/25/2010</td>
<td>New York DOT</td>
</tr>
<tr>
<td>Special – Geogrid, Type P2 (WT.05)</td>
<td>5,200</td>
<td>SY</td>
<td>$1.09</td>
<td>$2.51</td>
<td>$1.58</td>
<td>8</td>
<td>5/20/2010</td>
<td>New York DOT</td>
</tr>
<tr>
<td>Special – Geogrid, Type P2 (WT.05)</td>
<td>13,459</td>
<td>SY</td>
<td>$1.05</td>
<td>$2.51</td>
<td>$1.46</td>
<td>7</td>
<td>6/10/2010</td>
<td>New York DOT</td>
</tr>
<tr>
<td>Special – Geogrid, Type P2 (WT.05)</td>
<td>6,300</td>
<td>SY</td>
<td>$3.36</td>
<td>$3.52</td>
<td>$3.44</td>
<td>2</td>
<td>7/15/2010</td>
<td>Ohio DOT</td>
</tr>
</tbody>
</table>

Conceptual Cost Estimating Tool

Click here to open a cost estimating spreadsheet for producing a preliminary project scoping estimate. This conceptual cost estimating tool is intended to be used to develop a preliminary project scoping cost estimate. This preliminary estimate can be based on the typical construction cost item values as contained in the Cost Information product or from user specified cost values when such are known. Users should read and understand the information in Cost Information product prior to using the cost estimating tool.
# Conceptual Estimating Tool - Column Supported Embankment

**Notes to User:**

A. This estimating tool is provided as a means to perform an initial project scoping estimate. Use for any other purpose is strongly discouraged. The accuracy and reliability of the estimated costs are highly dependent upon the user inputs, care should be taken to adjust inputs for specific project characteristics. The user assumes all risks associated with the cost estimates produced by this estimating tool.

B. Guidance on unit cost ranges and potential impacts on cost is provided in the cost information summary for each technology. Users are responsible for determining appropriate unit costs.

## 1. Calculate the Surface Area Where Columns are to be Installed

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width (ft)</td>
<td>90</td>
</tr>
<tr>
<td>Area (ft²)</td>
<td>90,000</td>
</tr>
</tbody>
</table>

## 2. Estimate the Total Quantity of Columns to be Installed

<table>
<thead>
<tr>
<th>Estimated Longitudinal Grid Spacing (ft)</th>
<th>9.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Transverse Grid Spacing (ft)</td>
<td>9.00</td>
</tr>
<tr>
<td>Number of Columns to be Installed</td>
<td>1,044</td>
</tr>
<tr>
<td>Average Depth of Column Installation (ft)</td>
<td>3.00</td>
</tr>
<tr>
<td>Total Quantity of Columns (ft²)</td>
<td>77,175</td>
</tr>
</tbody>
</table>

## 3. If Needed, Estimate the Materials Required for an Initial Working Platform

| Quantity of Geosynthetic for a Working Platform (yd³) | 10,000 |
| Optional, Thickness of Granular Layer for Working Platform (in) | 12 |
| Optional, Estimated Density of Granular Material | 120 |
| Total Quantity of Granular Material for Working Platform (yd³) | 9,400 |

## 4. Calculate the Surface Area of Geosynthetic Reinforced Load Transfer Platform

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width (ft)</td>
<td>90</td>
</tr>
<tr>
<td>Number of Layers of Geosynthetic Reinforcement</td>
<td>3</td>
</tr>
<tr>
<td>Quantity of Geosynthetic Reinforcement (yd³)</td>
<td>30,000</td>
</tr>
</tbody>
</table>

## 5. Estimate the Quantity of Granular Material for the Load Transfer Platform

| Thickness of Granular Layer (in) | 36 |
| Estimated Density of Granular Material (lb/ft³) | 120 |
| Total Quantity of Granular Material (ton) | 16,200|

## 6. Estimated Cost of Column Supported Embankment - Refer to Cost Information Summary for Typical Unit Cost Ranges and Impacts on Unit Prices

- Optional, Geosynthetic for Working Platform (yd³) $2.75, 10,000 $27,500
- Optional, Granular Material for Working Platform (ton) $7.50, 5,600 $40,500
- Load Transfer Platform (yd³) $20,000, 1,044 $20,880
- Geosynthetic Reinforcement (yd³) $2.75, 9,400 $25,950
- Granular Material (ton) $10.00, 16,200 $162,000
- Credit Embankment for Volume of the Load Transfer Platform (yd³) $4.00, 10,000 $40,000

**Estimated Total Cost of Column Supported Embankment for Area Treated (yd³):** $2,687,750

**Estimated Unit Cost of Column Supported Embankment for Area Treated (yd³):** $26.90
Catalog of Technologies

About the Technologies Listed

Included are ground improvement and geostabilization technologies that are used for the following elements of construction:

- New embankment and roadway construction over unstable soils
- Roadway and embankment widening
- Geotechnical pavement components (base, subbase, and subgrade)
- Working platforms

An exception is that two traditional technologies—excavation and replacement, and traditional compaction—are included as often used “base” technologies, to which ground improvement and geostabilization methods are often compared.

Click here to view Catalog of Technologies with SHRP 2 R02 ratings that also allows comparison of selected technologies.

<table>
<thead>
<tr>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>◦ Aggregate Columns</td>
</tr>
<tr>
<td>◦ Beneficial Reuse of Waste Materials</td>
</tr>
<tr>
<td>◦ Bio-Treatment for Subgrade Stabilization</td>
</tr>
<tr>
<td>◦ Blasting Densification</td>
</tr>
<tr>
<td>◦ Bulk-Infill Grouting</td>
</tr>
<tr>
<td>◦ Chemical Grouting/Injection Systems</td>
</tr>
<tr>
<td>◦ Chemical Stabilization of Subgrades and Bases</td>
</tr>
<tr>
<td>◦ Column-Supported Embankments</td>
</tr>
<tr>
<td>◦ Combined Soil Stabilization with Vertical Columns</td>
</tr>
<tr>
<td>◦ Compaction Grouting</td>
</tr>
<tr>
<td>◦ Continuous Flight Auger Piles</td>
</tr>
<tr>
<td>◦ Deep Dynamic Compaction</td>
</tr>
<tr>
<td>◦ Deep Mixing Methods</td>
</tr>
<tr>
<td>◦ Drilled/Grouted and Hollow Bar Soil Nailing</td>
</tr>
<tr>
<td>◦ Electro-Osmosis</td>
</tr>
<tr>
<td>◦ Excavation and Replacement</td>
</tr>
<tr>
<td>◦ Fiber Reinforcement in Pavement Systems</td>
</tr>
<tr>
<td>◦ Grout Confined in Pavement Systems</td>
</tr>
</tbody>
</table>
Frequently Asked Questions

- How were technologies selected for inclusion in the project?
- Why were some technologies excluded?
- How were the ratings for each technology determined?
- What process was used in eliminating technologies in the interactive selection system?
- How do I suggest adding a technology?
- How do I access the cost estimating spreadsheets?
- What was the process utilized to develop the products?
- How do I submit a photograph or video for a technology?
- How do I submit a case history?
- 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?

**How were technologies selected for inclusion in the project?**

Included technologies are (1) technologies that have traditionally been deemed as ground improvement methods and (2) technologies that are used for the following elements of construction:

- New embankment and roadway construction over unstable soils
- Roadway and embankment widening
- Stabilization of pavement working platforms

An exception is that two traditional technologies, excavation and replacement and traditional compaction, are included as the “base” technologies often used, to which ground improvement methods are often compared.

**Why were some technologies excluded?**

This website was developed during Phase 2 of the project. Technologies were considered and evaluated during Phase 1 of the project. A detailed description of the process for identifying technologies can be found in the SHRPI R02 Phase 1 report. Technologies were selected for inclusion based on their applicability to the SHRPI R02 project goals.

**How were the ratings for each technology determined?**

Ratings for the technologies were initially developed in the Phase 1 work as described in the SHRPI R02 Phase 1 report. After completion of the Phase 2 work which took about three years, the project leaders re-evaluated each technology to develop the ratings provided in the system based on the information discovered in Phase 2. See the SHRPI R02 Technology Ratings Summar for a legend and detailed description of rating development.

**What process was used in eliminating technologies in the interactive selection system?**

During development of the system, technologies were conservatively eliminated during progression through the interactive selection system. During development of the individual geotechnical technology assessments, information regarding the applicability of each technology was highlighted. The applicability of each technology was then revised based on the expert opinions of the project team and advisory board.

A technically acceptable solution(s) is generally identified through the interactive selection system, rather than the optimal solution. The interactive system is intended to identify acceptable solutions. An expert typically learns through time and experience which solutions tend to work well and which solutions tend not to work. Thus, even though it is possible that a better solution might be missed, the apparently less-attractive solutions are eliminated in the selection process. The crux of the interactive selection system is that the solution(s) identified as a result of utilizing the system may or may not be the best or optimal solution. The best or optimal solution requires a project-specific evaluation using both technical and non-technical factors.

The following disclaimer was developed for the selection system. The application of this selection system is the responsibility of the user. It is imperative that the responsible engineer understand the potential accuracy limitations of the program results, independently cross checks those results with other methods, and examines the reasonableness of the results with engineering knowledge and experience.
Submit a Comment

Use the form below to submit a comment regarding this website to the project team.

Frequently Asked Questions

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:  Vernon R. Schaefer
*E-mail address:  vem@iastate.edu
Technology:  - Select a Technology -
*Comment regarding:  - Select an Area -
*Comment:

Submit Comment
Thank you!
Any Questions?

Partnerships for Progress in Transportation

LOUISIANA TRANSPORTATION CONFERENCE
February 17-20, 2013
River Center, Baton Rouge

RyanBerg@att.net
ACKNOWLEDGEMENTS

Research Team

The SHRP 2 R02 project research team consisted of private engineering consultants and university researchers having broad-based practice and research experience in geotechnical engineering, pavement engineering, and transportation applications. The project research team members included the following individuals:

SHRP 2 Project Manager

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Co-Principal Investigator and Co-Project Manager


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- Chadd Yeatts, Virginia Tech
Advisory Board

The SHRP 2 R02 project advisory board included the following individuals:

**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, North, LLC
- Mike Cowell – GeoConstructors, Inc.
- Seth Pearlman – DGI-Menards, Inc.
- Steve Saye – Kiewit Engineering
- Al Sehn – Hayward Baker