Minuteman National Park
Hanscom Drive Underpass

Completed: Spring 2005
Photo: October 2006
Minuteman National Park
Hanscom Drive Underpass

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Measures of Success
NPS Battle Road

• Construction Issues
  – Ease of construction
  – Affordability

• Performance
  – Engineering Standards
  – Aesthetics

• Maintenance
  – Does it last?
  – How easy to fix?
Stabilized Soils
Do They Work?

• Design Expectations
  – Aesthetics
  – Historic environments
  – Natural environments

• Functional Requirements
  – ADAAG and AAB requirements
  – Durability
Stabilized Soils
Maintenance Considerations

• Seasonal considerations
  – Certain rains – Inspection
  – No plowing

• Plan for repair
  – Edges, transitions, low points
  – Training
  – Material preparation
  – Material Storage

• “Use is maintenance”
Stabilized Soils
Design Considerations

• Grading Drainage
  – Slopes and approaches
  – Low points
  – Cross flow

• Transitions
  – Transitional materials
  – Anticipate maintenance

• Edge Conditions
  – Trees and shade
  – Compensating for cross section
## Cost Summary

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Upper Charles River Basin</th>
<th>Plymouth Seaside Rail Trail</th>
<th>National Park Service Minuteman Park Path At Hanscom Road</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Date</td>
<td>2004</td>
<td>2005</td>
<td>2005</td>
<td></td>
</tr>
<tr>
<td>Asphalt</td>
<td>---</td>
<td>---</td>
<td>$8/SY [$21/SY avg]</td>
<td>$9/SY '04 $15/SY '05</td>
</tr>
<tr>
<td>Organically Stabilized Stone Dust/Aggregate</td>
<td>$28/SY -</td>
<td>$41/SY</td>
<td>$8/SY [$23/SY avg]</td>
<td>---</td>
</tr>
<tr>
<td>Cement Stabilized Stone Dust Aggregate</td>
<td>---</td>
<td>---</td>
<td>$8/SY [$23/SY avg]</td>
<td>---</td>
</tr>
<tr>
<td>Chip Seal over 3.5 in Asphalt</td>
<td>---</td>
<td>---</td>
<td>$30/SY [$32/SY avg]</td>
<td>---</td>
</tr>
</tbody>
</table>
Table 15-1. Firmness, Stability, and Slip Resistance for a Variety of Common Trail Surfacing Materials

<table>
<thead>
<tr>
<th>Surface Material</th>
<th>Firmness</th>
<th>Stability</th>
<th>Slip Resistance (dry conditions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>firm</td>
<td>stable</td>
<td>slip resistant</td>
</tr>
<tr>
<td>Concrete</td>
<td>firm</td>
<td>stable</td>
<td>slip resistant*</td>
</tr>
<tr>
<td>Soil with Stabilizer</td>
<td>firm</td>
<td>stable</td>
<td>slip resistant</td>
</tr>
<tr>
<td>Packed Soil without Stabilizer</td>
<td>firm</td>
<td>stable</td>
<td>not slip resistant</td>
</tr>
<tr>
<td>Soil with High Organic Content</td>
<td>soft</td>
<td>unstable</td>
<td>not slip resistant</td>
</tr>
<tr>
<td>Crushed rock (3/4” minus) with Stabilizer</td>
<td>firm</td>
<td>stable</td>
<td>slip resistant</td>
</tr>
<tr>
<td>Crushed rock without Stabilizer</td>
<td>firm</td>
<td>stable</td>
<td>not slip resistant</td>
</tr>
<tr>
<td>Wood Planks</td>
<td>firm</td>
<td>stable</td>
<td>slip resistant</td>
</tr>
<tr>
<td>Engineered Wood Fibers that comply with ASTM F1951</td>
<td>moderately</td>
<td>moderately stable</td>
<td>not slip resistant</td>
</tr>
<tr>
<td>Grass or Vegetative Ground Cover</td>
<td>firm</td>
<td>stable</td>
<td>not slip resistant</td>
</tr>
<tr>
<td>Engineered Wood Fibers that do not comply with ASTM F1951</td>
<td>moderately firm</td>
<td>moderately stable</td>
<td>not slip resistant</td>
</tr>
<tr>
<td>Wood Chips (bark, cedar, generic)</td>
<td>soft</td>
<td>unstable</td>
<td>not slip resistant</td>
</tr>
<tr>
<td>Pea Gravel or 1-1/2” Minus Aggregate</td>
<td>moderately firm to soft</td>
<td>moderately stable to unstable</td>
<td>not slip resistant</td>
</tr>
<tr>
<td>Sand</td>
<td>soft</td>
<td>unstable</td>
<td>not slip resistant</td>
</tr>
</tbody>
</table>

*A broom finish significantly improves the slip resistance of concrete.*
Tested Materials with <1/4 limestone aggregate

• Mountain Grout* single component hybrid polyurethane system (name has been changed)

• Road Oyl Resin Modified Emulsion - a pine resin emulsion and is not petroleum

• Stabilizer - concentrated organic (ground seed hulls) soil additive powder.
# ANSI/RESNA Standards for Firmness and Stability

<table>
<thead>
<tr>
<th></th>
<th>Very Firm/ Stable</th>
<th>Moderately Firm/ Stable</th>
<th>Not Firm/ Stable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firmness</td>
<td>0.3 inch or less</td>
<td>&gt;0.3 &amp; &lt;0.5 inch</td>
<td>&gt;0.5 inch</td>
</tr>
<tr>
<td>Stability</td>
<td>0.5 inch or less</td>
<td>&gt;0.5 &amp; &lt;1.0 inch</td>
<td>&gt;1.0 inch</td>
</tr>
<tr>
<td>Application</td>
<td>Penetration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>-----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1/4” Limestone Mountain Grout</td>
<td>.009-.03 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1/4” Limestone with Road Oyl</td>
<td>.05-.08 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1/4” Limestone</td>
<td>.10-.90 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil and Mountain Grout Soil Stabilizer</td>
<td>.21-.87 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1/4” Limestone with Stabilizer</td>
<td>.36-.59 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% #11 Limestone and 50% soil</td>
<td>.45-1.2 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>.35-1.80 inches</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Porous Pavement
URI Study

Variety of Products and Recommendations

- Unit pavers
- “Grass Block” pavers
- Porous Concrete
- Porous Asphalt
Porous Pavement
Porous Pavement
EPA Technology Fact Sheet

FIGURE 1  TYPICAL POROUS PAVEMENT INSTALLATION
Porous Pavement
Walden Pond Study (1980)

Considerations
- Conditions: Hinckley excessively drained soils, plus testing to ensure excessively drained soils to 3 feet depth
- Four different porous cross sections developed
- Findings: clogging and compaction determined to be “major deterrent to full-scale use” of installations
Some specific disadvantages of porous pavement include the following:

- Many pavement engineers and contractors lack expertise with this technology.
- Porous pavement has a tendency to become clogged if improperly installed or maintained.
- Porous pavement has a high rate of failure.
Porous Pavement
URI Study (2005) – Porous Asphalt

• Cost of asphalt slightly more than conventional (OG course)
• Construction
  – Porous asphalt is installed over a 1” layer of chocker course
  – 18-36” bed of uniformly graded, clean washed crushed rock
  – Geotextile fabric separator
• Cost of base is more, expected to be offset by not having to provide drainage system
• Vacuum sweeping recommended for maintenance
Porous Pavement APPLICATION for Shared Use Path

Benefit/Cost Analysis

- Excavation requirements
- Evaluate true runoff vs. percolation
  - compare shoulder drainage
- Material requirements
- Maintenance requirements
- Clogging
Planning Considerations

Purpose of Alternative Surfaces

• Environmental – Low Impact Development
  – Runoff Impacts (?)
• Material Impacts to environment (?)
• Aesthetics
Research

• Better understanding of different products
  – Organic vs. Portland cement, lime, other materials
  – Surface stabilizers vs. mixed materials
  – UMass Study – Alternative Strategies– Dr. Mogawer
  – National Center on Accessibility Stabilized Soil Study
    http://www.ncaonline.org/trails/soil-study.shtml

• Environmental benefits

• Maintenance
  – Benefit cost studies
Thank Yous

• Carlisle Pedestrian and Pathway Committee, Deb Belanger, Eileen Faber
• Carol R Johnson & Associates, Kyle Zick, Senior Associate
• National Park Service Minuteman National Park– Nancy Nelson, Superintendent
• Department of Conservation and Recreation, Dan Driscoll, Planner
• MHD District 4 Construction
• MHD District 5 Construction
THANK YOU!

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