Revised S1120 - Mixture Design for Chemically Stabilized Soil

• Peter Narsavage, PE
Use 6% in the field.
# ODOT Proposal Notes, Supplemental Specifications, and Supplements

## 2010 Active Proposal Notes, Spec Book, Supplemental Specifications and Supplements

<table>
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<tr>
<th>Type</th>
<th>Number</th>
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<th>Name</th>
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### 2010 All Proposal Notes, Spec Book, Supplemental Specifications and Supplements

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# ODOT Proposal Notes, Supplemental Specifications, and Supplements

## 2010 Active Proposal Notes, Spec Book, Supplemental Specifications and Supplements

| Type | Number | Title                                                                 | Effective Date | Name                           | Designer Note | File Size |
|------|--------|                                                                      |                |                                |              |          |
| ![icon] | 1120   | Mixture Design for Chemically Stabilized Soils                      | 7/20/2007      | 1120_07202007_for_2010         |              | 57 KB    |
| ![icon] | 1125   | Testing and Acceptance of Mastic Supports for Reinforcing Steel    | 10/19/2007     | 1125_10192007_for_2010         |              | 55 KB    |

## 2010 All Proposal Notes, Spec Book, Supplemental Specifications and Supplements

- **Document Type**: Proposal Note (51)
- **Document Type**: Spec Book (1)
- **Document Type**: Supplement (103)
- **Document Type**: Supplemental Spec (39)

## 2008 Active Proposal Notes, Spec Book, Supplemental Specifications and Supplements

- **Document Type**: Proposal Note (56)
- **Document Type**: Spec Book (1)
- **Document Type**: Supplement (113)
Finding S 1120 on the web

- www.dot.state.oh.us
- Divisions > Construction Management > Online Documents > Proposal Notes, Supplemental Specifications, and Supplements
- Document Type: Supplement
- Scroll down to “more…”
Questions

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cell:(614) 562–1529
Reasons for Review/Revision

- Consistency between design (GB1) and construction (MOP204)
- Incorporate base reinforcement (i.e., geogrid) option
- Verify chemical stabilization strength and depth requirements through engineering analysis
- Analyze Rubblize and Roll requirement N_{60} > 15bpf
Consistency Between Design (GB1) and Construction (MOP204)
Consistency Between Design (GB1) and Construction (MOP204)

Figure 204.1 - Example using the Subgrade Treatment Chart
### GB1 Table B – Subgrade Stabilization

<table>
<thead>
<tr>
<th>Average N&lt;sub&gt;L&lt;/sub&gt;</th>
<th>Undercutting (feet)</th>
<th>Chemical Stabilization (inches)</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Depth N&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>Depth MN&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>Granular Material Replacement&lt;sup&gt;(4)&lt;/sup&gt;</td>
</tr>
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<td>0 to 5</td>
<td>6</td>
<td>6</td>
<td>Type B, C, or D</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>3</td>
<td>Type B, C, or D</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>3</td>
<td>Type B, C, or D</td>
</tr>
<tr>
<td>8</td>
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<td>Type B or C</td>
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<td>9</td>
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<td>Type B or C</td>
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<tr>
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<td>1</td>
<td>Type B or C</td>
</tr>
<tr>
<td>&gt; 15</td>
<td>0</td>
<td>1&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>Type B or C</td>
</tr>
</tbody>
</table>

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**Notes:**

1. N = low N<sub>60</sub> and acceptable MC according to GB1 Section C
2. MN = low N<sub>60</sub> and excess MC according to GB1 Section C
3. Only if the MC exceeds optimum by more than 5 percent
4. Determine appropriate granular material type for specified undercut depth
5. Always use Item 204 Geotextile Fabric when undercutting
6. Determine type of chemical stabilization according to GB1 Section G
7. Undercut up to 5 feet to remove all problematic soil, if not, undercut 3 feet
Consistency Between Design (GB1) and Construction (MOP204)

- **Undercut Design Methodology**
  - Experience (current GB1, MOP204)
  - Modified Steward (USACE, USFS)
  - Giroud–Han
Consistency Between Design (GB1) and Construction (MOP204)

• Inputs
  - Subgrade strength
  - Vehicle passes
  - Equivalent axle loads (wheel loads)
  - Axle configurations
  - Tire pressure
  - Rut depth
  - Aperture stability modulus

• Unpaved Analysis
Consistency Between Design (GB1) and Construction (MOP204)

- Subgrade Strength
  - Blow counts
  - Unconfined compressive strength
  - Rut depth
  - CBR
## Consistency Between Design (GB1) and Construction (MOP204)

<table>
<thead>
<tr>
<th>$N_{60}$</th>
<th>$q_u$ (tsf)</th>
<th>$q_u$ (psi)</th>
<th>CBR ($q_u/2/4.3$)</th>
<th>Rut Depth (in)</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>0.25</td>
<td>3.47</td>
<td>0.4</td>
<td>12+</td>
</tr>
<tr>
<td>4</td>
<td>0.5</td>
<td>6.94</td>
<td>0.8</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>0.75</td>
<td>10.42</td>
<td>1.2</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>13.89</td>
<td>1.6</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>1.25</td>
<td>17.36</td>
<td>2.0</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>1.5</td>
<td>20.83</td>
<td>2.4</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>1.75</td>
<td>24.31</td>
<td>2.8</td>
<td>1</td>
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</table>
Consistency Between Design (GB1) and Construction (MOP204)

- Rut depth = 1"
- 1000 passes
- 80 psi tire pressure
- 9000 lb wheel load

Graph showing the relationship between CBR and undercut for various materials and conditions.
Consistency Between Design (GB1) and Construction (MOP204)

Draft

- Unreinforced
- Geogrid
Consistency Between Design (GB1) and Construction (MOP204)

Draft

- Unreinforced
- Geogrid

Undercut (in) vs. $N_{60L}$

GB1/MOP 204 Review/Revision
Consistency Between Design (GB1) and Construction (MOP204)

Draft

- Unreinforced
- Geogrid

Rut Depth (in)

Undercut (in)
Consistency Between Design (GB1) and Construction (MOP204)

Design Charts/Graphs are not Finalized!
Incorporate Base Reinforcement Option

  - Average $N_L < 5$ bpf
  - Avoid impact on utilities below subgrade
  - Avoid difficult maintenance of traffic situations
  - Granular thickness $> 14''$, fabric on bottom, grid in middle
Incorporate Base Reinforcement Option

<table>
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<tr>
<th>Property</th>
<th>Test Method</th>
<th>Required Value</th>
<th>Notes</th>
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<tr>
<td><strong>Reinforcement Properties</strong></td>
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<tr>
<td>Strength at 2% Strain</td>
<td>ASTM D 6637</td>
<td>400 lb/ft</td>
<td>5.8 kN/m</td>
</tr>
<tr>
<td>Minimum Opening Size</td>
<td>Direct Measure</td>
<td>0.75 in [2]</td>
<td>19 mm</td>
</tr>
<tr>
<td>Maximum Opening Size</td>
<td>Direct Measure</td>
<td>3.0 in [3]</td>
<td>76 mm</td>
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<tr>
<td><strong>Survivability Index Values</strong></td>
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<tr>
<td>Ultimate Tensile Strength</td>
<td>ASTM D 6637</td>
<td>1230 lb/ft</td>
<td>18 kN/m</td>
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<tr>
<td>Ultraviolet Stability</td>
<td>ASTM D 4355</td>
<td>70 % at 500 hrs</td>
<td></td>
</tr>
</tbody>
</table>

[^1] Values, except ultraviolet stability, are minimum average roll values, MARV (average value minus two standard deviations.) Strength values are the minimum value in either the machine or cross-machine direction.

[^2] Minimum opening size must be ≥ $D_{50}$ of aggregate above geogrid to provide interlock.

[^3] Maximum opening size must be ≤ $2 \times D_{85}$ to prevent aggregate from penetrating into the subgrade.

[^4] GRI – Geosynthetic Research Institute
Incorporate Base Reinforcement Option


<table>
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<th>Table 5-5</th>
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<tr>
<td>Geogrid Survivability Property Requirementsootnote{1,2,3} For Stabilization and Base Reinforcement Applications</td>
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<table>
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<tr>
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<th>Test Method</th>
<th>Units</th>
<th>Requirement</th>
<th>Geogrid Class</th>
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<td>SURVIVABILITY</td>
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<td>lb/ft (kN/m)</td>
<td>1230 (18)</td>
<td>CLASS 1ootnote{4}</td>
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<td>GSI GRI GG2</td>
<td>lb (N)</td>
<td>25ootnote{5} (110ootnote{5})</td>
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<td>Ultraviolet Stability (Retained Strength)</td>
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<td>%</td>
<td>50% after 500 hours of exposure</td>
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<th>OPENING CHARACTERISTICS</th>
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<td>Aperture Size</td>
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<td>Separation</td>
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Chemical Stabilization Strength and Depth Requirements

• Analyze using AASHTO2002 4.4.7.1.1.7, Bearing Capacity of Layered Soils
  – Undrained Loading ($\phi = 0$) of a 2-layered cohesive soil system
  – Stiff soil over soft soil; assume punching shear
  – Assume $FS=3$
Chemical Stabilization Strength and Depth Requirements

Chemical Stabilization Thickness (100 psi) vs $q_u$

Chemical Thickness (in)

$q_u$ (tsf)
Chemical Stabilization Strength and Depth Requirements

Chemical Stabilization Thickness (100 psi) vs N$_{60}$

- **Analysis**
- **GB1**
- **MOP204**

Chemical Thickness (in)

N$_{60}$
Chemical Stabilization Strength and Depth Requirements

• Conclusions
  – 100 psi strength for stabilized layer appears adequate
  – May consider chemical stabilization for $N_{60} < 5\text{bpf}$
  – Current depth requirements are adequate
Putting it All Together in the MOP204

DRAFT

Undercut Depth, feet

with geogrid & geotextile

with geotextile

Depth of chemical stabilization

HP (tsf) 0 0.25 0.5 1.0 1.5 2.0 2.5 3.0

Rut Depth from Proof Roller 0 2 4 6 8 10 12 14 16

N (blows/ft) 0 2 4 6 8 10 12 14 16

16" 14" 12"

GB1/MOP 204 Review/Revision
Analyze Rubblize and Roll requirement $N_{60} > 15 \text{bpf}$

- Much Rubblize and Roll on BUT/WAR–75–3.76/1.90
  - Design CBR = 6
  - Average $N_L = 16$
  - 19% of borings exhibited $N_L < 10$
  - All planned rubblize and roll was successful
Analyze Rubblize and Roll requirement $N_{60} > 15 \text{ bpf}$

- Rubblize and Roll on WAR–75–3.40
  - $6 < N_L < 10$ for 36 of 117 borings
  - $11 < N_L < 15$ for 35 of 117 borings
- Plan to observe 3,700 feet of R/R where average $N_L$ ranges from 10 to 13 bpf (in May 2010)
Questions?