North Carolina Study Compares Lime Treated Soil to Remove-and-Replace

A Common Problem: Soft, wet, weak soil can prove to be a major challenge on many construction sites. Construction vehicles sink into the soil as they move, causing “ruts”—deep depressions—that make passage difficult. Recurring rain storms compound the problem, leaving the site a muddy mess that is difficult for workers and impassable for vehicles delivering construction material.

Common Solutions: Two common construction techniques to rectify this problem are:

1) Remove the weak soil and replace it with more suitable material, often crushed aggregate base course. This is called “remove-and-replace” or “cut-and-fill.”

2) Mix lime into the existing soil. Lime dries and modifies the soil, making it less plastic and more suitable for compaction.

The Best Choice: The decision as to which technique to use depends on a number of factors, including:

- Cost
- Project size
- Contractor capabilities and preferences
- Material availability
- Disposal options (for remove and replace)
- Equipment access or operating constraints
- Existing soil types and soil conditions

Each project should be evaluated on a case-by-case basis by a competent geotechnical engineer, site work contractor and soil stabilization specialty contractor. Neither solution is always best in all situations.

Research Gives Guidance: While both solutions can be effective for many projects, the better choice, in terms of cost and performance, is not always obvious. A study* conducted at North Carolina State University (NCSU), and sponsored by the North Carolina Department of Transportation provides valuable insight on the questions:

- Which solution performs better?
- Which solution costs less?

Lime Performed Best: In the study, a variety of laboratory test sections were constructed and tested using a weak soil that is representative of typical subgrade conditions found in many parts of the U.S. and Canada. The lime treated subgrade test section performed best, carrying over 10,000 simulated construction loads with less than ¼” of rutting. The test section comprised of 12” ABC with geofabric separating the ABC layer and subgrade soil layer showed the most rutting of all the test sections.

Lime Costs Less: The study also determined the comparative costs of the various test sections for typical construction projects, based on unit-price bid tabulations compiled by the North Carolina Department of Transportation in 2008 and in-place cost estimates of the tested geogrid and geofabric materials as provided by the product producers. Again, the lime treated test section proved to be the superior alternative, costing about 50% of the lowest cost remove-and-replace option.

Further evaluation of the study’s cost data shows an even more impressive finding. Although it was not one of the 22 test sections, a 12” layer of lime stabilized subgrade without 4” of ABC—a commonly used option in much of the U.S.—yields a comparative cost of $5.40 per SY, (also based on unit-price bid tabulations compiled by the North Carolina Department of Transportation in 2008).

<table>
<thead>
<tr>
<th>Test Configuration</th>
<th>Unit Cost ($/SY)</th>
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</thead>
<tbody>
<tr>
<td>12” Lime Stabilized Soil*</td>
<td>$5.40</td>
</tr>
<tr>
<td>9” Lime Stabilized Soil with 4” ABC</td>
<td>$10.44</td>
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<tr>
<td>14” Agg Base Course</td>
<td>$20.18</td>
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<tr>
<td>12” Agg Base Course with Geofabric</td>
<td>$22.59</td>
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<tr>
<td>16” Agg Base Course with Geogrid</td>
<td>$24.34</td>
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<tr>
<td>20” Agg Base Course</td>
<td>$28.82</td>
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</tbody>
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*This section was not evaluated in the NCSU study
As part of extensive research conducted at North Carolina State University*, a variety of test sections were constructed and tested with simulated construction loads. Additionally, typical construction costs for the alternatives were determined using unit cost information from North Carolina Department of Transportation bid tab records.

The research results are graphically presented in the chart below. The lime-treated soil performed best (less rutting) and cost less than all the remove-and-replace options.
