Lime Treated Soil Works Better and Costs Less

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.

### Comparing Lime Treatment to Remove-and-Replace for Construction Site Soil Improvement

#### WHICH WORKS BEST?

- **High Displacement**
  - Low Cost
  - *12" ABC with Geotextile A*

- **High Displacement**
  - High Cost
  - *14" Select Fill with 3" ABC and Geotextile A*

- **Low Displacement**
  - Low Cost
  - *9" Lime Treated Soil with 4" ABC*

- **Low Displacement**
  - High Cost
  - *16" ABC with Geogrid B*

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#### WHICH COSTS LESS?

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- **Low Displacement**
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  - *16" ABC with Geogrid B*

### Notes

Poor soil conditions cause construction problems

Soft, weak soil can prove to be a major challenge on many construction sites. Construction vehicles sink into the weak soil causing deep depressions – "ruts" – that make passage difficult. Excessive rain storms can complicate the problem, leaving the construction site a muddy mess that's difficult for workers and impassable for vehicles delivering construction materials.

Further problems occur when efforts are made to compact the soil for use under roads, parking lots, building slabs or other paved areas. It’s difficult to reach the soil moisture and compaction and proof-roll requirements established by the project civil or geotechnical engineer. Wet, poorly compacted soil makes for poor pavement support, decreasing pavement performance and service life. Poor soil conditions cause construction delays, which costs money.

AND SITE WORK CONTRACTORS LOSE TIME AND MONEY.

Common solutions – remove-and-replace or lime treated soil

Two common construction techniques to rectify this problem are remove-and-replace or lime treated soil.

With remove-and-replace, the weak soil is excavated – typically to a depth of 12" to 24" – and replaced with a more suitable material – often crushed aggregate base course. A synthetic geofabric or geogrid material is sometimes placed on the soil before the aggregate base course is placed.

Another common technique is to mix lime into the existing soil. Lime reacts quickly to dry the soil and reduce soil plasticity. The compacted lime-treated soil – between 9" and 16" in depth – is much stronger than the untreated soil, making it capable of carrying construction vehicles and serving well as pavement support.

Which works better and costs less?

The decision as to which technique to use to improve the soil at the construction site 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

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

North Carolina study provides valuable insight

While both solutions can be effective for many projects, the better choice, in terms of cost and performance, is not always obvious. Valuable insight on the questions:

- Which solution performs better,
- Which soil condition is provided in a study conducted at North Carolina State University (NCSU), sponsored by the North Carolina Department of Transportation.

In this large scale laboratory study, 22 different configurations of aggregate base course (ABC), selected fill or lime treated soil were placed on a weak soil and then repeatedly loaded to simulate proof rolling and construction traffic. Permanent displacement (rutting) was carefully measured, allowing a direct comparison of the performance of the various subgrade improvement techniques. Additionally, information from North Carolina DOT construction bid tab summaries were compiled to determine the typical NCDOT construction costs for the various alternatives.

The result – the most comprehensive study ever done to compare lime treatment to remove-and-replace to determine:

- Which performs best?
- Which costs less?

Lime Performed Best

In the study, 22 test sections were constructed and tested using a weak soil that is representative of subgrade conditions found in 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 1/4" of rutting. The test section comprised of 12" of ABC with geosynthetic separating the ABC layer and subgrade soil showed the most rutting of the 22 test sections.

Lime Costs Less

The study also determined the comparative costs of the 22 test sections to the construction projects, based on unit-price bid tabulations compiled by the North Carolina Department of Transportation in 2008 and in-place cost data of the treated geosynthetic 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 soils, 4" of lime treated subgrade without 4" of ABC – a commonly used option in much of the U.S. – yields a comparative cost of $2.29 per SY, (based on unit-price bid tabulations compiled by the North Carolina Department of Transportation in 2008).

Better Performance for the Money

Using material cost data and transportation cost, the study found that lime treated subgrade and aggregate base course.

For pavement subgrade and construction site soil improvement research shows that treating the soil with lime works better and costs less than soil removal and replacement with aggregate base course.
Poor soil conditions cause construction problems

Soft, weak soil can prove to be a major challenge on many construction sites. Construction vehicles sink into the weak soil causing deep depressions – “bogs” – that makes passage difficult. Raining or storms can compound the problem, leaving the construction site a muddy mess that’s difficult for workers and impassable for vehicles delivering construction material.

Further problems occur when efforts are made to compact the soil for use under roadways, parking lots, building slabs or other paved areas. It’s difficult to reach the soil moisture and compaction and proof-roll requirements established by the project civil or geotechnical engineer. Wet, poorly compacted soil makes for poor pavement support, decreasing the performance and service life.

Natural drying takes too long and is often hampered by unpredictable and uncontrollable rain showers. Work gets delayed, construction schedules slip, deadlines are missed. OWNERS, GENERAL CONTRACTORS, and a layer of geosynthetic material – often crushed aggregate base – typically to a depth of 12” to 24” – and replaced with a more suitable material – often crushed aggregate base course. A synthetic geosynthetic or geogrid material is sometimes placed on the soil before the aggregate base course is placed.

Another common technique is to mix lime into the existing soil. Lime reacts quickly to dry the soil and reduce soil plasticity. The compacted time-lime treated soil – between 9” and 16” in depth – is much stronger than the untreated soil, making it capable of carrying construction vehicles and serving well as pavement support.

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While both solutions can be effective for many projects, the better choice, in terms of cost and performance, is not always obvious. Valuable insight on the questions:

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Lime Costs Less

In the study, 22 test sections were constructed and tested using a weak soil that is representative of subgrade conditions found in 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 1/4" of rutting. The test section comprised of 12" of ABC with geosynthetic separating the ABC layer and subgrade soil layer showed the most rutting of the 22 test sections.

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Better Performance for the Money

Using information from DOT unit bid costs as documented in the North Carolina State University study, an investment of $5.40 would buy:

- 4” of remove-and-replace with ABC
- 2” of remove-and-replace with ABC

and a layer of geosynthetic material

- 12” of lime treated soil.

Lime or remove-and-replace? The choice is clear. LIME!
Poor soil conditions cause construction problems

Soft, weak soil can prove to be a major challenge on many construction sites. Construction vehicles sink into the weak soil causing deep depressions – "rutting" – that makes passage difficult. Wet, poorly compacted soil compounds the problem, leaving the construction site a muddy mess that’s difficult for workers and impassable for vehicles delivering construction material.

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Two common construction techniques to rectify this problem are “remove-and-replace” or lime treated soil. With remove-and-replace, one layer of weak soil is excavated – typically to a depth of 12" to 24" – and replaced with a more suitable material – often crushed aggregate base course. A synthetic geotextile or geogrid material is sometimes placed on the soil before the aggregate base course is placed. Another common technique is to mix lime into the existing soil. Lime reacts quickly to dry the soil and reduce soil plasticity. The compacted lime treated soil – between 9" and 16" in depth – is much stronger than existing soil. Lime reacts quickly to dry the soil and reduce soil plasticity. The compacted lime treated soil is much stronger than existing soil. Lime reacts quickly to dry the soil and reduce soil plasticity. The compacted lime treated soil is much stronger than existing soil. 

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Lime Costs Less

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 2" layer of lime treated 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).

Better Performance for the Money

Using information obtained from dollar amounts documented in the North Carolina State University study, an investment of $5.40 would buy:
- 4" of remove-and-replace with ABC - OR -
- 2" of lime treated soil with a layer of geosynthetic material - OR -
- 12" of lime treated soil

Lime or remove-and-replace? The choice is clear. LIME!
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Lime Treated Soil is Best and Costs Less

WHICH WORKS BEST?
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