USING LIME FOR SOIL STABILIZATION AND MODIFICATION

A PROVEN SOLUTION!

LIME MEETS THE CONSTRUCTION CHALLENGE: Lime is an unparalleled aid in the modification and stabilization of soil beneath road and similar construction projects. Using lime can substantially increase the stability, impermeability, and load-bearing capacity of the subgrade. And lime is a *proven* solution--witness the more than *one million metric tons* of lime used annually in the U.S. for soil modification and stabilization.

LIME AND SOIL *MODIFICATION*: Lime is an excellent choice for short-term *modification* of soil properties. Lime can modify almost all fine-grained soils, but the most dramatic improvement occurs in clay soils of moderate to high plasticity. Modification occurs because calcium cations supplied by the hydrated lime replace the cations normally present on the surface of the clay mineral, promoted by the high pH environment of the lime-water system. Thus, the clay surface mineralogy is altered, producing the following benefits:

- Plasticity reduction
- Reduction in moisture-holding capacity (drying)
- Swell reduction
- Improved stability
- The ability to construct a solid working platform

These benefits expedite construction and save time and money. (For more information, see NLA's factsheet on using lime to dry up mud, at http://www.lime.org/mud.pdf.)

LIME AND SOIL *STABILIZATION*: Soil *stabilization* occurs when lime is added to a reactive soil to generate *long-term strength gain* through a pozzolanic reaction. This reaction produces stable calcium silicate hydrates and calcium aluminate hydrates as the calcium from the lime reacts with the aluminates and silicates solubilized from the clay. The full-term pozzolanic reaction can continue for a very long period of time, even decades -- as long as enough lime is present and the pH remains high (above 10). As a result, lime treatment can produce high and long-lasting strength gains. The key to pozzolanic reactivity and stabilization is a reactive soil, a good mix design protocol, and reliable construction practices.

Benefits of soil stabilization include:

- Very substantial increases in resilient modulus values (by a factor of 10 or more in many cases)
- Very substantial improvements in shear strength (by a factor of 20 or more in some cases)
- Continued strength gain with time, even after periods of environmental or load damage (autogenous healing)
- Long-term durability over decades of service even under severe environmental conditions.

These performance benefits translate into short- and long-term economic benefits.

- In the short-term, considering the structural contribution of lime-stabilized layers in pavement design can create more cost-effective design alternatives. A recent interstate project in

Pennsylvania, for example, began with a $29.3 million traditional design approach. An alternate design using lime stabilization, consistent with AASHTO mechanistic-empirical designs, cost only $21.6 million—more than 25 percent savings! (Qubain et al., *Incorporating Subgrade Lime Stabilization into Pavement Design*, Transportation Research Board Meeting, January 2000.)

- In the longer term, lime stabilization provides performance benefits that reduce maintenance costs. To illustrate, stabilizing an 8-inch native clay subgrade with lime as part of an asphalt pavement project can reduce 30-year life cycle costs from $24.49 to $22.47 per square yard (from a life cycle methodology illustration in *Stabilization of Pavement Subgrades & Base Courses with Lime*, see below).

In addition to stabilization of new materials, lime is an excellent choice for the reclamation of roadbases. As more and more governmental entities are choosing to reclaim existing roadbases rather than replace them, this use of lime will become even more important.

Lime stabilization is not difficult to carry out. After proper mix design and testing is performed, in-place mixing is usually used to add the appropriate amount of lime to soil, mixed to an appropriate depth. Pulverization and mixing is used to thoroughly combine the lime and soil. For heavy clays, preliminary mixing may be followed by 24 to 48 hours (or more) of moist curing, followed by final mixing. For maximum development of strength and durability, proper compaction is necessary. Proper curing is also important. If sulfates are present at levels greater than 0.3 percent, special procedures are required.

Additional details on mixture design and testing protocols appear in NLA's *Evaluation of Structural Properties of Lime Stabilized Soils and Aggregates, Volume 3: Mixture Design and Testing Protocol for Lime Stabilized Soils*, by Dr. Dallas N. Little of Texas A&M University (see reference list below).

Other methods of lime stabilization include in-plant mixing and pressure injection.

For more information, including technical papers on soil stabilization, check NLA's website at http://www.lime.org. Several useful documents can be downloaded free of charge and others can be ordered online, including:

- *Evaluation of Structural Properties of Lime Stabilized Soils and Aggregates (3 volumes)*
- *Fundamentals of the Stabilization of Soil with Lime*
- *Lime Stabilization Construction Manual*
- *Guidelines for Stabilization of Soils Containing Sulfates*
- *A Long Range Durability Study of Lime Stabilized Bases*
- *Lime Slurry Pressure Injection Manual*
- *Stabilization of Pavement Subgrades & Base Courses with Lime*
- *Lime Dries Up Mud*

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