

Soil Stabilization

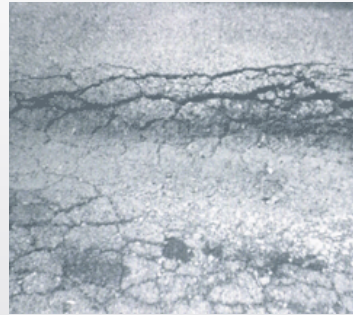
*The future of sustainable structural sub-bases
and solutions for unsuitable soils.*



Introduction

- Unsuitable soils can greatly increase the difficulty of a construction project. Many times, traffic from construction equipment causes deep depressions making passage and grading difficult, if not impossible. Further problems occur when specific compaction requirements are necessary in order to pass inspection on subgrades for roadways, parking lots, building pads, and other structural areas.
- If the bearing ratio (CBR) of the soil on site is unsuitable for the desired project design the following options usually take place:
 - Change in design for the project
 - Remove and replace the soil - \$\$\$
 - Abandon the site for development - ☹

Poor soil conditions cause major construction challenges and poor quality infrastructure if not properly accounted for.



Excessive Rutting



Swelling Soils



Depressions or "ruts"



Common Solutions

- Remove and Replace

This operation typically includes excavating the weak soils 12" to 24" and replacing with suitable material, usually geotextile and crushed aggregate.



Undercut for roadway

- Soil Stabilization



This operation includes mixing lime or cement into the existing soils. The lime and cement react quickly to lower the plasticity of the soil.



Spreading cement for soil stabilization

Lime Stabilization

Lime

- Lime stabilization can use several modifications of lime in order to achieve stabilization. The effects of stabilization are achieved through quicklime, CaO or hydrated lime, $\text{Ca}(\text{OH})_2$.
- Quicklime is most commonly used due to its structural properties such as:
 - High available free lime content per unit of mass.
 - More dense than hydrated lime, equaling less dust and storage space.
 - The reaction generates heat which causes additional moisture precipitation.

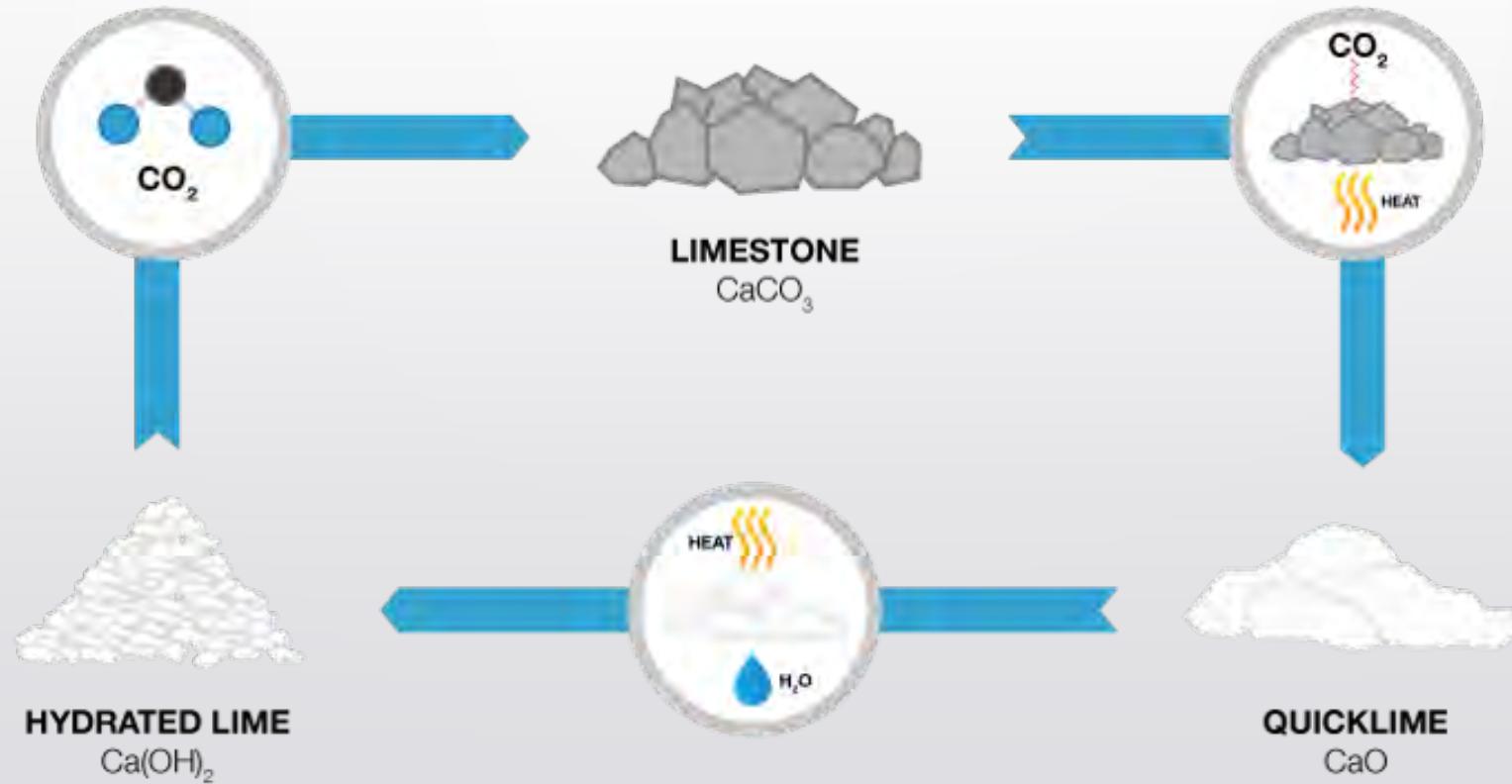


Quicklime – CaO

Chemistry of Lime Treatment

- After the introduction of quicklime into the soil, the lime hydrates and releases heat.
- Once mixing has occurred, the calcium ions (Ca^{++}) from the quicklime rise to the surface of the clay particles displacing water and other ions. The soil then becomes granular making it easier for grading and compaction, at this stage the Plasticity Index decreases causing its shrink / swell properties to decrease accordingly.
- Stabilization occurs as specific amounts of lime and water are mixed into the soils in order to increase the pH over 10.5. Silica and alumina are released within the soils to react with the calcium from the lime forming calcium-silicate-hydrates (CHS) and calcium-aluminate-hydrates (CAH). These two compounds (CHS and CAH) have properties that closely resemble Portland Cement.
- After grading and compaction, the matrix formed is relatively permanent, durable, and impermeable.

Chemistry of Lime Treatment



Cement Stabilization

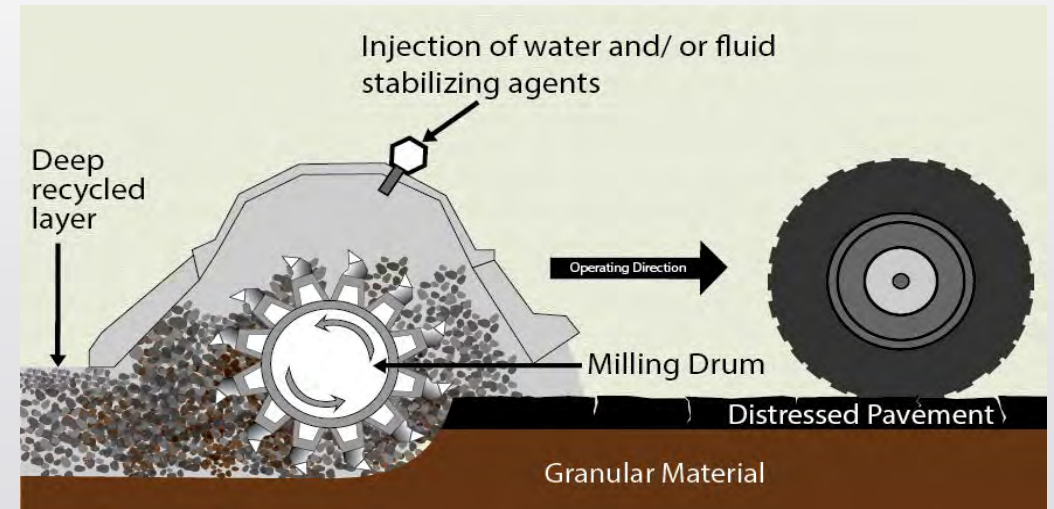
• What is Soil Cement?

- Soil cement is a compacted mixture of soil or aggregate, Portland cement, and water. Soil cement is mostly used as a low cost pavement base and enhances the soil's properties much like lime stabilization does.



Portland cement

- Cement stabilization is most commonly used for full depth reclamation (FDR). FDR is a pavement rehabilitation operation in which, the full flexible pavement section is reclaimed and uniformly pulverized with a stabilizing agent such as Portland Cement.



Soil reclamation animation

Construction Sequence

Step One: Evaluate the soil and determine its structural properties.



- Before any lime or cement is added to soil for stabilization, a geotechnical engineer should evaluate the current soil conditions and create the mix design accordingly.
- The mix design is variable for all types of soils.

Equation Example: Pounds of Cement or Lime per Square Yard

$$\frac{3}{4} * D * WD * \%$$

where:

9 ft² in a square yard

9 ft² /yd² x (one inch deep)/12 inches/ft = ¾ ft³/yd² per one inch deep

D = depth (inches)

WD = average density (lb/ft³)

% = percent cement (expressed as a decimal)

Construction Sequence Cont.'

Step Two: Delivery & Spreading

- The most common method for delivery of lime or cement is through tanker trucks. The desired product is pumped into the spreader wagon.
- The specified amount of product determined during the engineering phase in step one is entered into the computer on the spreader equipment. This ensures the soil is being treated with the proper amount of lime or cement.



Cement tanker and spreader wagon

Construction Sequence Cont.'

Step Three: Pulverizing and Achieving Moisture

- After the lime or cement has been applied to the desired area at the determined grade, the product is ready to be mixed into the soil at the correct depth.
- This operation utilizes the Wirtgen –WR 250 (shown in the picture). This machine has the capability of a pulverizing depth of 22” through soil, aggregate, and asphalt.
- It is at this stage, in the stabilization process, that the desired moisture content is achieved. Moisture is achieved through utilizing a water truck. Occasionally the moisture content in the unsuitable soil will be adequate to meet specification requirements.



J.R. Caskey's WR-250 mixing cement to a depth of 18"

Construction Sequence Cont.'

Step Four: Compaction & Grading

- After the mixing operation has taken place the surface is ready for compaction and grading.
- Compaction should begin as soon as possible after the initial mixing. The surface is compacted to the density required by specification, usually at least 95% of the maximum density obtained by the proctor test.
- Final grading should take place during this phase of the stabilization operation. This is commonly done by utilizing a motorgrader or bulldozer.

Compaction is achieved through utilizing a sheepfoot, padfoot, or smooth drum roller.



J.R.Caskey's Vibratory Sheepfoot Roller and GPS Motor Grader

How can J.R.Caskey Site Development be of service to you?

★ *J.R. Caskey Inc. Site Development delivers high quality infrastructure built Safely and with Integrity.*

J.R. Caskey strives towards changing the negative perception of construction's impact on the environment. Soil stabilization aids in not only the quality, but construction scheduling and cost basis of America's Infrastructure while being environmentally friendly. Stabilization provides a green alternative for site construction by "upsizing" otherwise useless soils into a product that can be used rather than filling our landfills with unsuitable soils.

J.R. Caskey utilizes the highest quality equipment with state of the art technology. Our GPS grading components allow us to grade efficiently, achieving faster production rates saving time and machine emissions.

J.R. Caskey believes in teamwork, not only between ourselves but with our construction partners. We work in unison to provide ideas, solutions, experienced leadership and quality equipment to overcome the obstacles that arise in construction.

★ Let us assist you and your business partners to invest in the pursuit of quality infrastructure while simultaneously investing in our future and environment.

BEFORE



AFTER

