Effectiveness of Various Lime Products for Soil Drying

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Wet, Unstable Subgrade Material

Poor engineering characteristics when wet (low strength, difficult construction, potential for pumping)
Wet Site Conditions

Delays embankment construction (multiple lifts)
Wet, Unstable Soil

Cause construction delays

Delays cost money
What to Do?

Wait for Natural Drying -
- Low investment
- Slow
  - Lost time = lost $
- More rain
- Large uncertainty
- No soil improvement
What to Do?

Remove and Replace -
- Very effective
- Costly
- Slow
- Disposal issues
- Impacts surrounding community
What to Do?

Lime Treatment -
- Very effective
- Acts rapidly
- Uses existing soil – no disposal issues
- Improves soil properties
  - Reduces plasticity
  - Increase strength
    - Short term
    - Long term
- Cost effective
CaCO₃ + MgCO₃ → CaO + MgO + CO₂

CaO + MgO --- “Quicklime”
Lime Products for Treating Soil

Quicklime - (CaO and MgO)
1. High Calcium Quicklime
2. Dolomitic Quicklime

3. Hydrated Lime - Ca(OH$_2$)

Lime Kiln Dust:
4. High Calcium Lime Kiln Dust
5. Dolomitic Lime Kiln Dust
   - Available CaO $\approx$ 18% - 30%
Lime Hydration

Quicklime + Water $\rightarrow$ Hydrated Lime

CaO + H$_2$O $\rightarrow$ Ca(OH)$_2$

Calcium Oxide + Water $\rightarrow$ Calcium Hydroxide
Soil Drying

\[ \text{CaO} + \text{MgO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + \text{Mg(OH)}_2 \]

Quicklime + Water  →  Hydrated Lime

Quicklime absorbs 40% of its weight in water.

Hydration lets off heat, Driving off water thru Increased evaporation.
Lime Modified Soils have a **New** Optimum Moisture Content

![Graph showing dry density (PCF) versus OMC (percent)]

OMC = 17%
Lime Modified Soils have a **New, Higher** Optimum Moisture Content

**OMC = 17%**

**OMC = 21%**
Effective Change of Moisture Content

Net Effective Change of 3% Lime
In Moisture Content for Compaction:

Decrease in Moisture Content: 3%
New-Higher OMC: 4%
Net Effective Change: 7%
Lime Products for Treating Soil

1. High Calcium Quicklime

2. Dolomitic Quicklime

3. Hydrated Lime - Ca(OH$_2$)

4. High Calcium Lime Kiln Dust

5. Dolomitic Lime Kiln Dust
Soils Evaluated

1. Chicago – O-Hare
   \(\text{P.I.} = 7\) (SC, A-2-6) \(\text{OMC} = 12.2\%\)

2. US-30 – Ohio
   \(\text{P.I.} = 24\) (CL, A-6) \(\text{OMC} = 15.9\%\)

3. Near Dulles Airport, VA
   \(\text{P.I.} = 26\) (CL, A-6) \(\text{OMC} = 20.6\%\)

4. Point Potomac, VA
   \(\text{P.I.} = 37\) (CH, A-7-6) \(\text{OMC} = 24.8\%\)
Moisture Decrease 4 Hours After Mixing
Net Effective Change - 24 Hours After Mixing
(OMC Increase plus Moisture Decrease)
Average Effectiveness for “Soil Drying”
(OMC Increase plus Moisture Decrease)
For All Four Soils – 24 hrs After Mixing
% of 24-hr Moisture Reduction and OMC Increase That Occurs in the First 4 Hours
**Effect of Remixing on Soil Drying**
*(24 hours After Initial Mixing With 4% High Calcium Quicklime)*