CARMEUSE

Chemical Modification and Stabilization of Subgrade

and Associated Quality Assurance

Craig Addison

February, 12th 2020
Williamsburg, VA

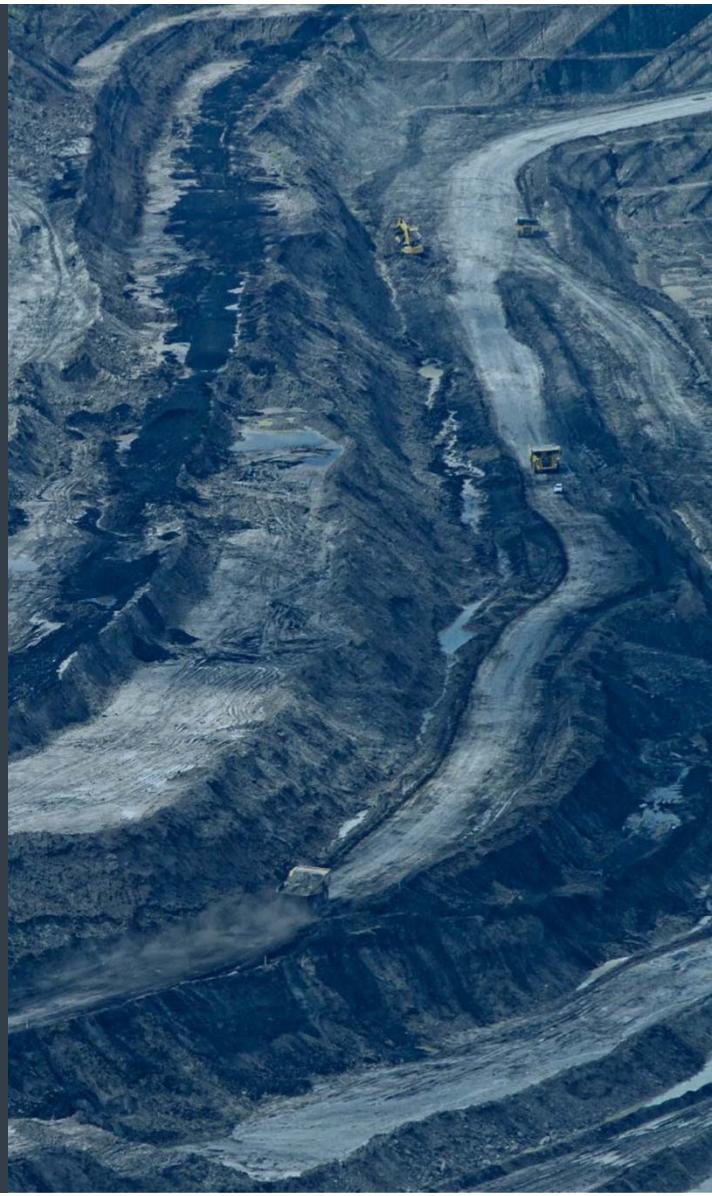
Agenda

0 1 Goals of Chemical Modification

0 2 Stabilization Options

0 3 The Right Product for the Right Soil

0 4 Mix Design and Testing



01

Goals of Chemical Modification

Goals of Chemical Modification

- Reduce shrink/swell of expansive soils or existing materials.
- Increase strength to provide long-term support for the pavement structure.
- Reduce pavement thickness.
- Reduce moisture susceptibility and migration.
- Utilize local materials.
- Provide a working platform for construction of subsequent layers by drying out wet areas and/or increasing strength properties.
- Save money and/or time!

There are many options when dealing with difficult subgrade materials

Quicklime

- ASTM C977/ AASHTO M216
- Consists of calcium and magnesium oxides
- Limits the amount of carbon dioxide
- Limits moisture
- Available lime reacts rapidly with moisture
- Specification also includes hydrated lime

Lime Kiln Dust

- No national standard for LKD
- Co-product of quicklime production
- Blend of quicklime and fly ash
- Provides additional pozzolanic reactivity in leaner clay soils
- Standard DOT specification include
  - Combined totals CaO and MgO
  - Limit of carbon dioxide as LOI
  - Moisture
  - Sulfate
  - Minimum gradation

Lime/FlyAsh Blends

- ASTM C593
- Blend of quicklime and fly ash
- Specification includes chemical and physical properties
- Option for type C and F ash
- Evaluation based on strength

Portland cement

- ASTM C150
- Blend of calcium silicates and calcium aluminates
- Typically type I cement is used
- Type II cement has been used – sulfate attack

CARMEUSE

Quicklime and Lime Kiln Dust Modification and Stabilization

Dry

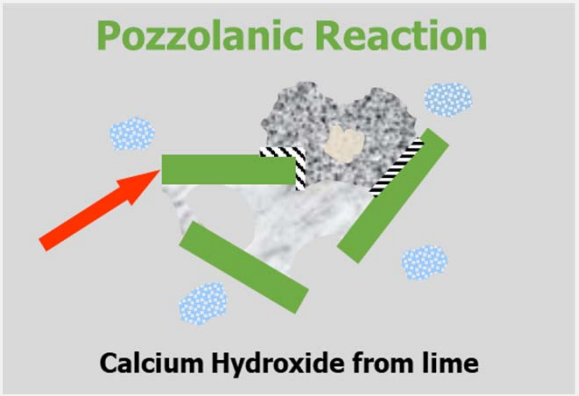
- Fast and effective
- Chemically bound water
- Evaporative heat generation
- Reduced moisture-holding capacity

Modify

- Reduce plasticity
- Minimize shrink swell potential
- Improved compaction
- Increase in shear strength

Stabilize

- Increased pH solubilizes Si and Al from clays
- Increased strength and durability
- Lower absorption/moisture barrier
- Reduced Freeze-thaw susceptibility



Cement Modification and Stabilization

Dry/Modify

- Cement hydration binds water
- Dry bulking agent
- Minimize shrink swell potential
- Increase in shear strength

Before

Image Source: Cement.org

Stabilize

- Hydration of cement forms CSH and CAH
- Increased strength and durability
- Lower absorption
- Reduced Freeze-thaw susceptibility

Generalized Additive Selection Guideline

Laboratory Evaluations for Lime Stabilization

1. **pH Determination for Minimum Lime Content**
   - ASTM D 6276 (Eads – Grim Test)
   - Min amount of lime to raise soil pH level to 12.4
2. **Optimum Moisture Content**
   - ASTM D 698 (Standard Proctor Density)
   - Generally increases with lime
   - Mellow period
3. **Unconfined Compressive Strength**
   - ASTM D 5102
   - Minimum of 125 psi for most states
   - Freeze-thaw durability

Laboratory Evaluations for Soil-cement

1. **Optimum Moisture Content**
   - ASTM D 558 (~ASTM D698)
   - Allows for reuse of material
   - ¾" material with 4" mold
2. **Unconfined Compressive Strength**
   - ASTM D 1633
   - Compressive strength varies by design
3. **Freeze-Thaw testing**
   - ASTM D 560
   - Compaction with D558
   - Freeze-thaw durability

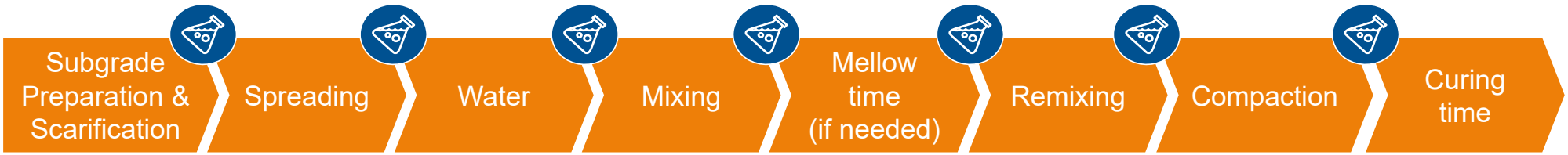

Image Source: Geo-Hydro


Image Source: SCPA

Stabilization field testing

General Requirements

Safety, treatment depth, temperature limitations, wind restrictions, etc.



- Moisture density testing
- Rough grade

- Ensuring correct dosage
- Pan test

- Ensure there is enough moisture for hydration

- Powered reclaimer
- Proper gradation

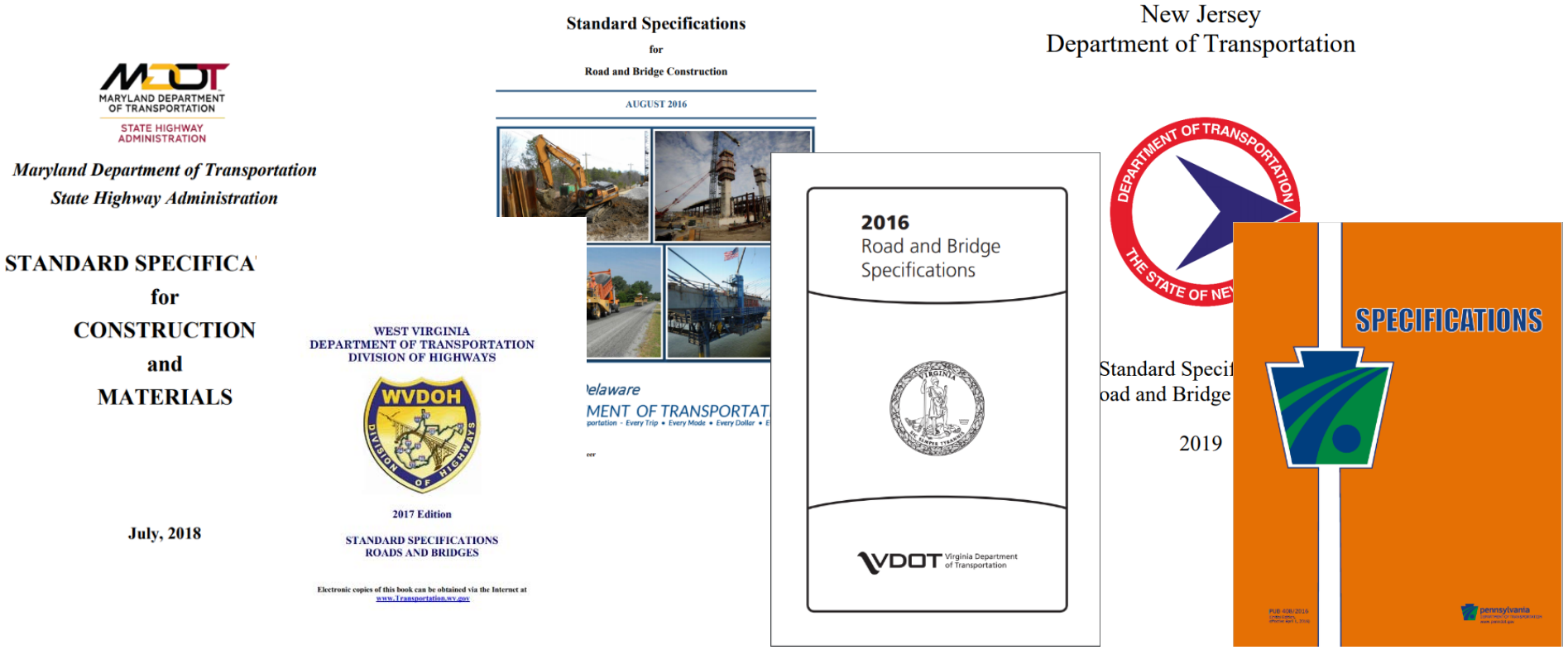
- Variable stage based on many factors

- Powered reclaimer
- Proper gradation

- Post stabilization moisture density

- Bituminous cover
- Allowing

Ensuring you have the tools to handle any site



CARMEUSE

Thank you

COMMITMENT TO
ZERO INJURIES