Innovative Applications of Cement and Concrete for Public Works

Cement Stabilized Base

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Since its founding in 1916, the Portland Cement Association has had the same mission: "Improve and expand the uses of portland cement and concrete."

**Divisions**
- Market Promotion
- Research
- Technical Services
- Codes and Standards

**Affiliates**
- American Concrete Pavement Association
- National Ready Mix Concrete Association
- Cement Association of Canada
Regional Promotion Groups

- Northwest Cement Producers Group
- Rocky Mountain Cement Council
- North Central Cement Council
- Great Lakes Cement Promotion Association
- Northeast Cement Shippers Association
- California Nevada Cement Promotion Council
- Arizona Cement Association
- Cement Council of Texas
- South Central Cement Promotion Association
- Southeast Cement Association
What is Cement Stabilization?

• Mixture of portland cement, soil/aggregate and water
• Pulverized, mixed, compacted to high density
Cement-Based Pavement Materials

- Roller-Compacted Concrete
- Soil-Cement
- Cement-Modified Soil
- Full-Depth Reclamation
- Cement-Treated Base
- Conventional Concrete
- No Wearing Course
- Wearing Course
- Flowable Fill
- Cast
- Rolled

Water Content

Cement Content
Cement-Modified Soil

• Small addition of cement to soils to change properties
• Eliminates removal/replacement of inferior soils
• Low cost soil improvement
• Improves pavement support
• Forms weather-resistant work platform
• Provides permanent non-leaching modification
Cement-Treated Base (mixed in place)

- Low first cost and life cycle cost
- Allows thinner pavement sections
- Utilizes in-situ materials
- Reduces use of virgin aggregates
- Reduces moisture susceptibility
- Frost resistant
Full-Depth Reclamation (FDR)

- Special case of mixed-in-place CTB (with aggregate spec)
- Pulverization and recycling of asphalt and base
- Utilizes existing materials
- Fast and convenient
- Eliminates new base
- Environmentally friendly
Cement-Treated Base
(plant mixed)

- Treatment of graded aggregates with cement
- Lower cost through use of local or marginal aggregates
- Eliminates subgrade infiltration into base
Roller Compacted Concrete
Cement-Bound Materials in Pavements

- Bituminous surface
- Conventional or Roller-Compacted Concrete
- Whitetopping
- Surface course
- Base/Subbase course
- Treated subgrade
- Untreated subgrade
- RCC
- Cement-treated base
- FDR
- Cement-modified soil
Cement Stabilization History

• 70 years of successful pavements
• Diverse geographic areas (used all over North America, and extensively around the world)
• Wide variety of soil types
  – Gravels
  – Sands
  – Silts
  – Clays
“Portland Cement is probably the closest thing we have to a universal stabilizer.”

Cement-Modified Soil

- Cement factors normally 1% to 3%
- Reduces or eliminates swell potential of plastic soils
- Reduces plasticity index (PI)
- Increases bearing ability of granular or plastic soils
- Produces workable foundation for pavements
Solutions to Poor Clay Subgrades

- Excavation/replacement with select fill
- Increasing base/pavement thickness
- Modify clay with chemical stabilizer
By treating the soil chemically *(calcium-based stabilizers)*, the detrimental properties of clay can be improved through the following processes:

- 1. Particle Restructuring
- 2. Cement Hydration
- 3. Pozzolanic Reaction
Chemical Stabilizers:

- Cement – Restructure(1), Hydration(2), Pozzolanic(3) if combined with clay or fly ash
- Lime – Restructure(1), Pozzolanic(3) if combined with clay or fly ash
- Class C Fly Ash (more than 20% free lime) – Restructure(1), Pozzolanic(3)
- Class F Fly Ash – Pozzolanic(3) if combined with calcium-based stabilizer
Cement Modification Results

- Significant, immediate reductions in PI and shrinkage limit
- Strength improves immediately and increases over years
- Compaction can occur immediately--no “mellowing period” necessary
- Cement stabilization is permanent and tends to improve with age
Why Use CTB?

• Most economical pavement base available
• Decreased base thickness compared to unbound aggregate base
• Structural properties maintained under varying moisture conditions
• High stiffness inhibits fatigue cracking and rutting of asphalt surface.
Mix Proportioning

- Representative sample of material
- Pulverize to anticipated gradation
  - 100% passing 200 mm (2”)
  - 55% passing 6 mm (#4)
- Add estimated cement content
  - Usually 4-8 %, by weight
- Run moisture/density curve
  - Standard proctor (ASTM D558)
Moisture/Density Relationship

![Graph showing the relationship between moisture content and dry density, with the maximum dry density and optimum moisture content indicated. The graph is based on ASTM D558.](image-url)
Mix Proportioning

- Determine cement content:
  - Durability tests
    - Wet/dry - ASTM D559
    - Freeze/thaw - ASTM D560
  - Unconfined compressive strength
    - ASTM D1633
  - Tube suction test
    - Being developed by Texas A&M
Strive for a Balance Between Strength and Performance
Processing Methods

• Mixed-in-place
  – Spread portland cement and mix
  – Apply water and re-mix

• Central mixing plant (pug mill or batch plant)
  – Mix soil/aggregate, cement and water
  – Haul mixed material to placing area
  – Spread soil-cement uniformly
Cement Spreading

- Cement is spread on top of roadway in measured amount
Blending and Moisture Addition

- Cement is blended into pulverized, recycled material
- Water is added to optimum moisture
Grading
Compaction

- Material is compacted
- 95% Proctor density minimum
Curing

• Proper curing is essential
  – Water
  – Bituminous compound
Surfacing

- Surface course applied as soon as material is stable under load (typical 1-2 days)
  - Asphalt
  - Chip seal
  - Concrete
Quality Control: Thickness
Moisture Content
Quality Control: Density
Plant-Mixed CTB
Pug Mill
Cement Treated Permeable Base
Cement-Treated Permeable Base
for additional information, please visit our website at www.cement.org/pavements