Full-Depth Reclamation with Cement

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Course Instructor:

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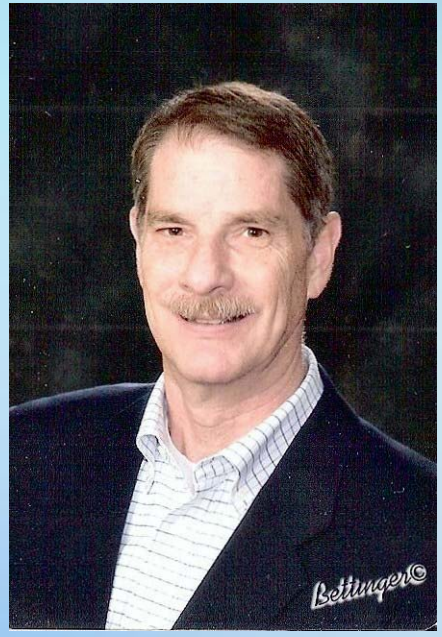
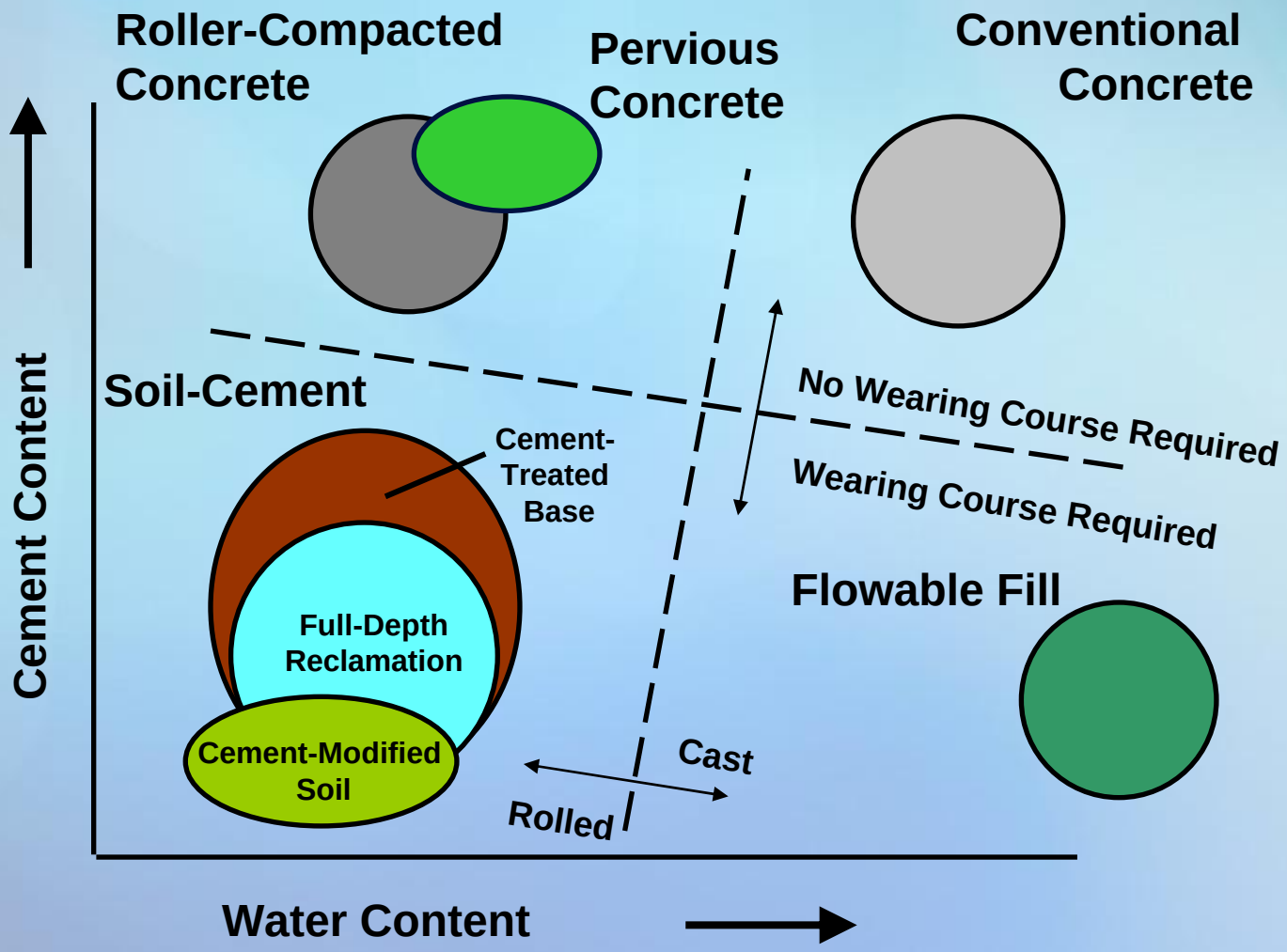


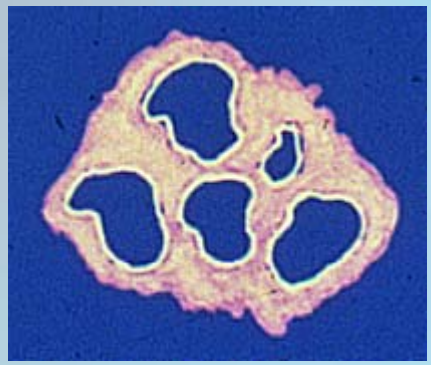
- Introduction
- Applications
- Benefits
- Design
- Construction
- Field Testing
- Performance

Introduction

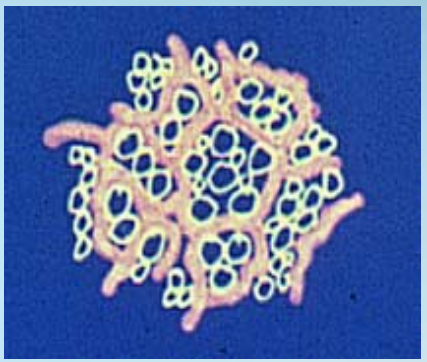
Cement-Based Pavement Materials



Concrete



Soil-Cement



Cementitious Gel or Paste

- coats all particles
- fills voids

Hydration Products

- all particles not coated
- voids not filled
- linkages bind soil agglomerations together

Definition of Full-Depth Reclamation

- Method of flexible pavement reconstruction that utilizes the existing asphalt, base, and subgrade material to produce a new stabilized base course for a chip seal, asphalt, or concrete wearing surface.

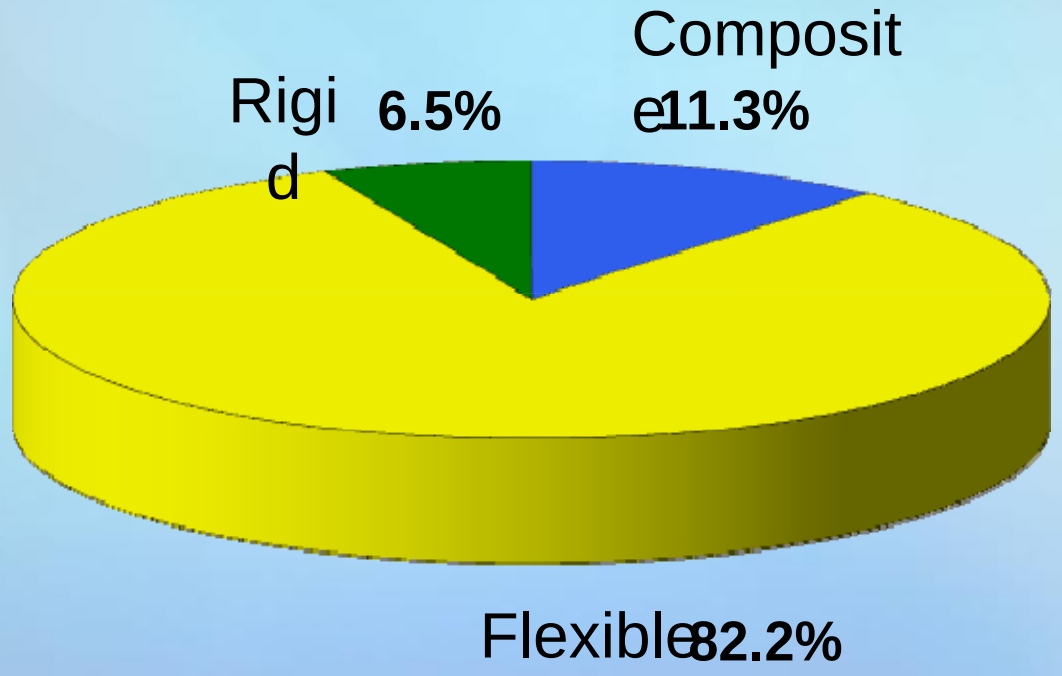
Types of Reclamation Methods

- Mechanical Stabilization
- Bituminous Stabilization
  - emulsified asphalt
  - expanded (foamed) asphalt
- Chemical Stabilization
  - portland cement
  - slag cement
  - fly ash
  - kiln dust
  - lime
  - other

Applications

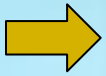
Surfaced Roadways in the United States

(2,495,000 total centerline miles)



Challenges Facing Our Roadways

- Continuing growth
- Rising expectations from users
- A heavily used, aging system
- Environmental compatibility
- Changes in the workforce
- Funding limitations



Combined with large increases in traffic volumes and/or allowable loads often leads to serious roadway base failures!

How do you know if you have a base problem and not just a surface deficiency?

Examples of Pavement Distress

- Alligator cracking
- Rutting
- Excessive patching
- Base failures
- Potholes
- Soil stains on surface

Benefits

Advantages of the FDR Process

- Use of in-place materials
- Little or no material hauled off and dumped
- Maintains or improves existing grade
- Conserves virgin material
- Saves cost by using in-place "investment"
- Saves energy by reducing mining and hauls
- Very sustainable process

Benefits of FDR with Cement

- Increased rigidity spreads loads
- Eliminates rutting below surface
- Reduced moisture susceptibility
- Reduced fatigue cracking in asphalt surfacing
- Allows for thinner pavement section

Rehabilitation Strategies

Attribute	Rehabilitation Strategy		
	Reclamation with Cement	Structural Overlay	Removal and Replacement
New pavement structure	√	√	√
Fast construction	√	√	X
Minimal traffic disruption	√	X	X
Minimal material in/out	√	X	X
Conserves resources	√	X	X
Maintains existing elevation	√	X	√
Low cost	√	X	X

Sustainable Element of FDR Process

1 mile of 24-foot wide, 2-lane road, with a 6-inch base

Design

Pavement Thickness Design Procedures

- 1993 AASHTO Pavement Design Guide
  - Structural Numbers
  - Layer Coefficients
- Proposed New AASHTO Design Guide
  - Mechanistic-Empirical Design
  - Evaluates effects of pavement materials, traffic loading conditions, environmental factors, design features, and construction practices

Pavement Materials Tests

- Sieve Analysis (ASTM C136)
- Atterberg Limits (ASTM D4318)
- Moisture-Density (ASTM D558)
- Durability Tests
  - Wet-Dry (ASTM D559)
  - Freeze-Thaw (ASTM D560)
- Soluble Sulfates (ASTM C1580)
- Compressive Strength (ASTM D1633)

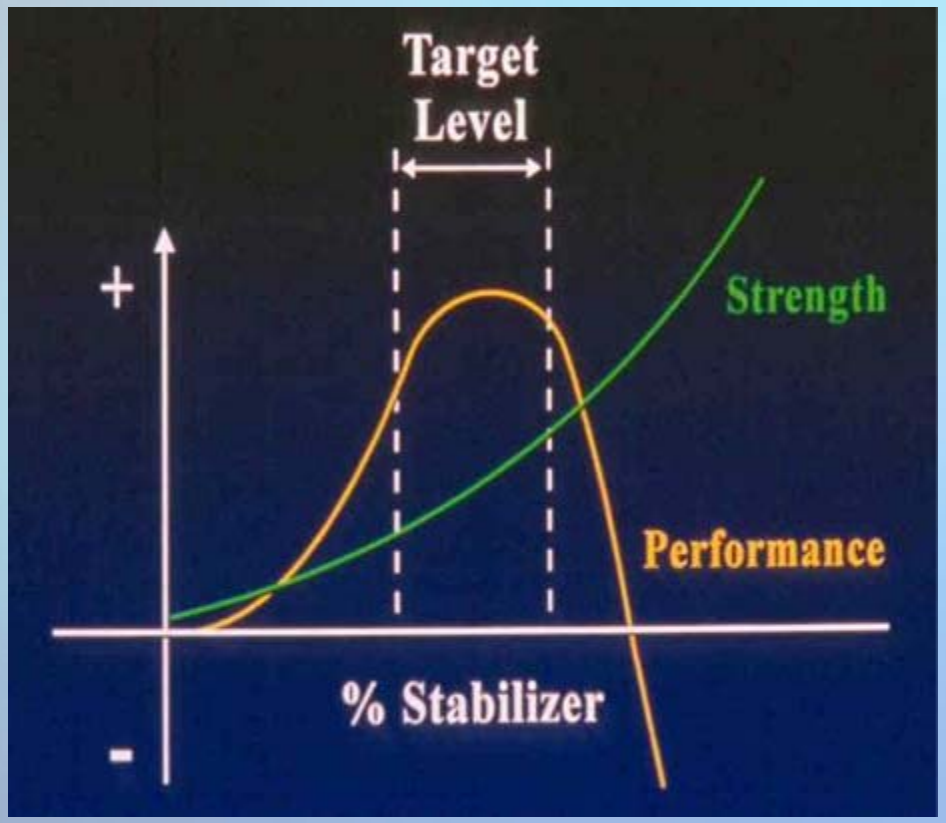
Laboratory Mix Design

- Obtain representative samples of roadway material
- Usually about 100 pounds of material is required
- Determine the maximum dry density and optimum moisture content at various cement percentages (ASTM D558)
- Typical designs vary between 2 and 8 percent cement by weight of dry material
- Prepare samples
- Cure samples

Strength Determination

- **Unconfined Compressive Strength Testing**
  - ASTM D1633
  - Used by most governing agencies
  - Simple and quick procedure
  - 7-day strengths ranging from 300 to 400 psi are generally recommended
  - Proven strength (support) under extremely heavy traffic conditions
  - Proven performance (durability) in wet-dry and freeze-thaw environments

Please keep in mind that strength and performance are NOT the same thing!

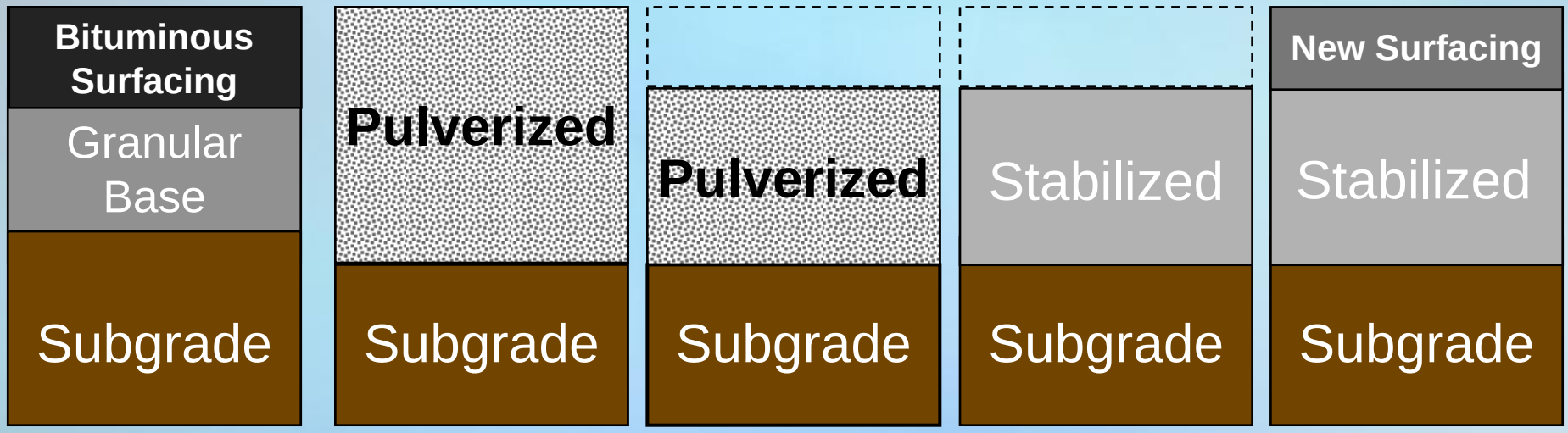


The purpose of the mix design procedure is to select the correct amount of stabilizer that most closely balances both strength AND performance for the roadway materials!

Construction

FDR Construction Process

Pulverize, Shape, Add Cement, Mix In Place, Compact, and Surface



Existing road

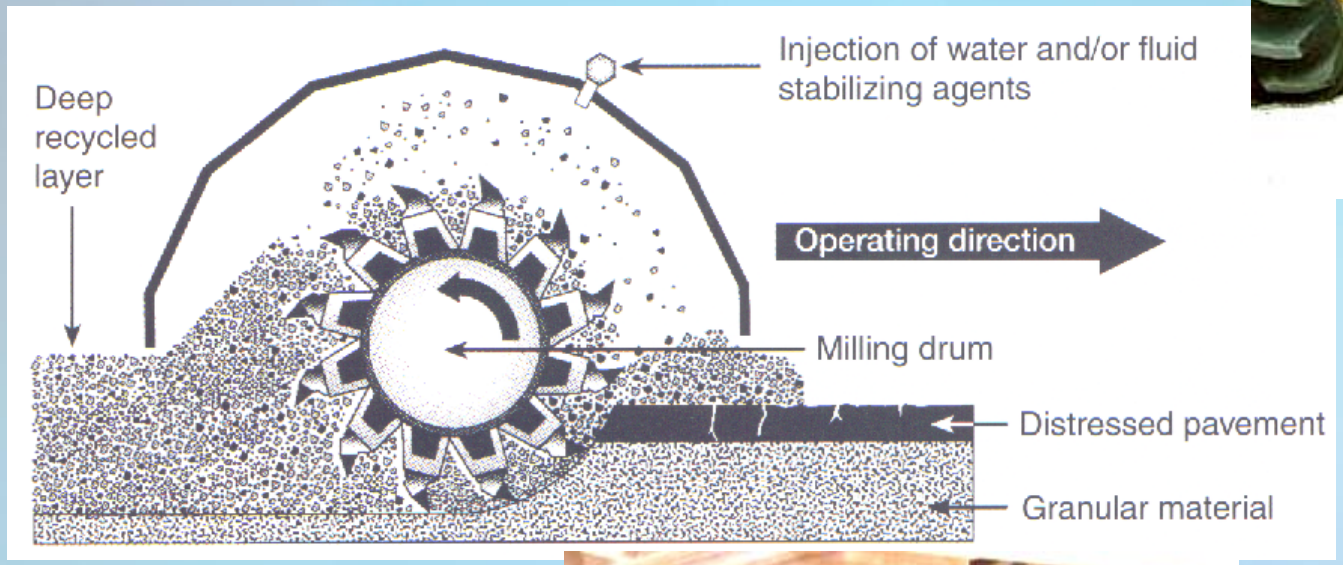
Pulverization to desired depth

Removal of excess material (if necessary) and shaping

Addition of cement, mixing, reshaping, and compaction

Final surface application

Inside a Reclaimer



Pulverization

- Pulverize mat to appropriate gradation
- Usually, only one pass is required!

Cement Spreading

Cement is spread on top of the pulverized material in a measured amount in either a dry or slurry form

Blending of Materials and Moisture Addition

Cement is blended into pulverized, reclaimed material and, with the addition of water, is brought to optimum moisture

Compaction and Grading

Material is compacted to 96 to 98 percent minimum standard Proctor density and then graded to appropriate Plan lines, grades, and cross-sections

Curing

Bituminous Compounds (cutbacks or emulsions)

Water
(kept continuously moist)

Field Testing

Testing Requirements

Gradation/Uniformity

A common gradation requirement is for 100 percent to pass a 3-inch sieve, a minimum of 95 percent to pass a 2-inch sieve, and a minimum of 55 percent to pass a No. 4 sieve (ASTM C136).

Density

A common density requirement is to be between 96 and 98 percent of the established laboratory standard Proctor density (ASTM D558).

Moisture

A common moisture requirement is to be within 2 percent of the laboratory established optimum moisture content (ASTM D558).

Traffic and Surfacing

- Completed FDR base can be opened immediately to low-speed local traffic and to construction equipment
- Subsequent pavement layers can be placed at any time

Case Studies

Laramie County, Wyoming

- Started using FDR for county roads in 2007

Little Sahara Rec Area

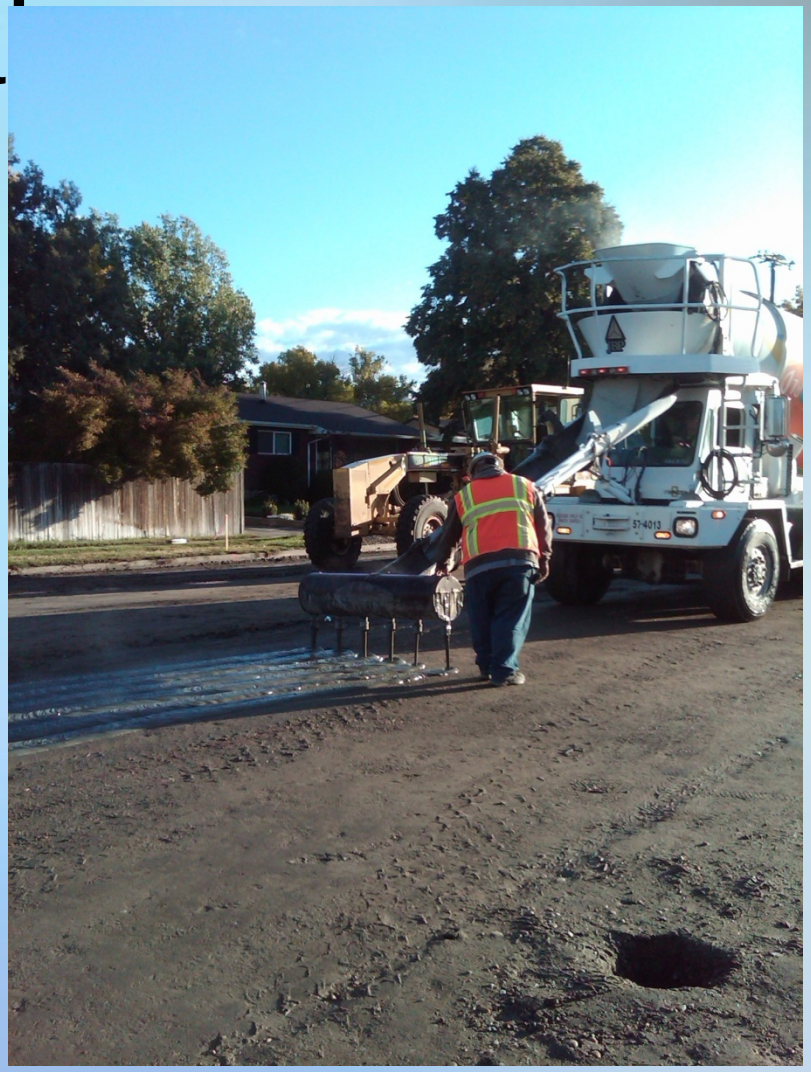
- 60,000 acres in south central Utah
- Reclaimed over 14 miles of park road
- Decision to use cement over another stabilizer saved $350,000

Richland County, Montana

- Just completed third year of FDR of chip seal and gravel roads
- Cement content developed for each road reclaimed – around 7%
- 2012 project included 29 miles

Spanish Fork, Utah

- Two block long reconstruction project
- FDR process with cement saved $33,000 (21%) over conventional reconstruction
- Used micro-cracking
- Used the “Coyle” spreader



Counties who have purchased rec

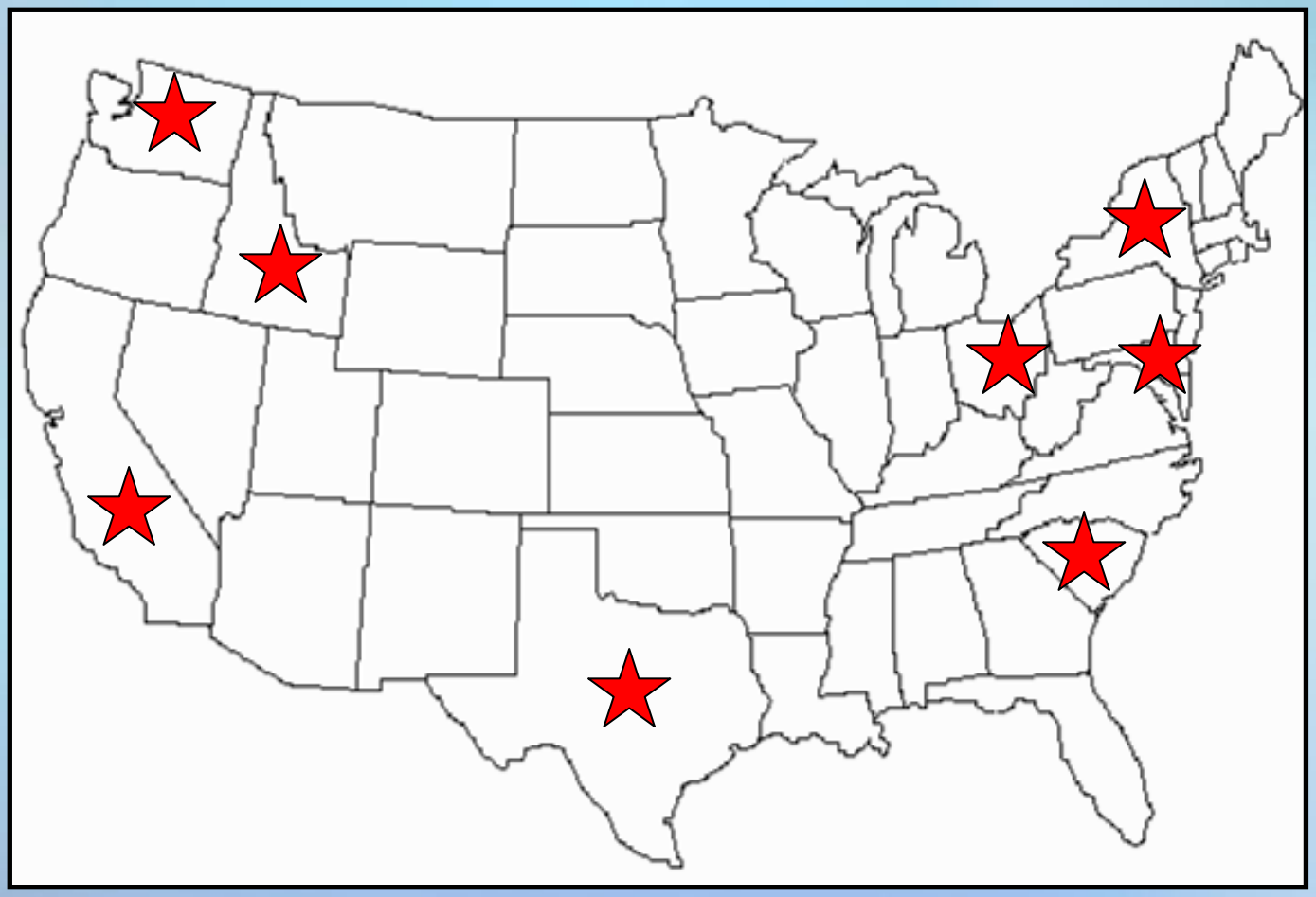
- Weld County, Colorado
- Montrose County, Colorado

Performance

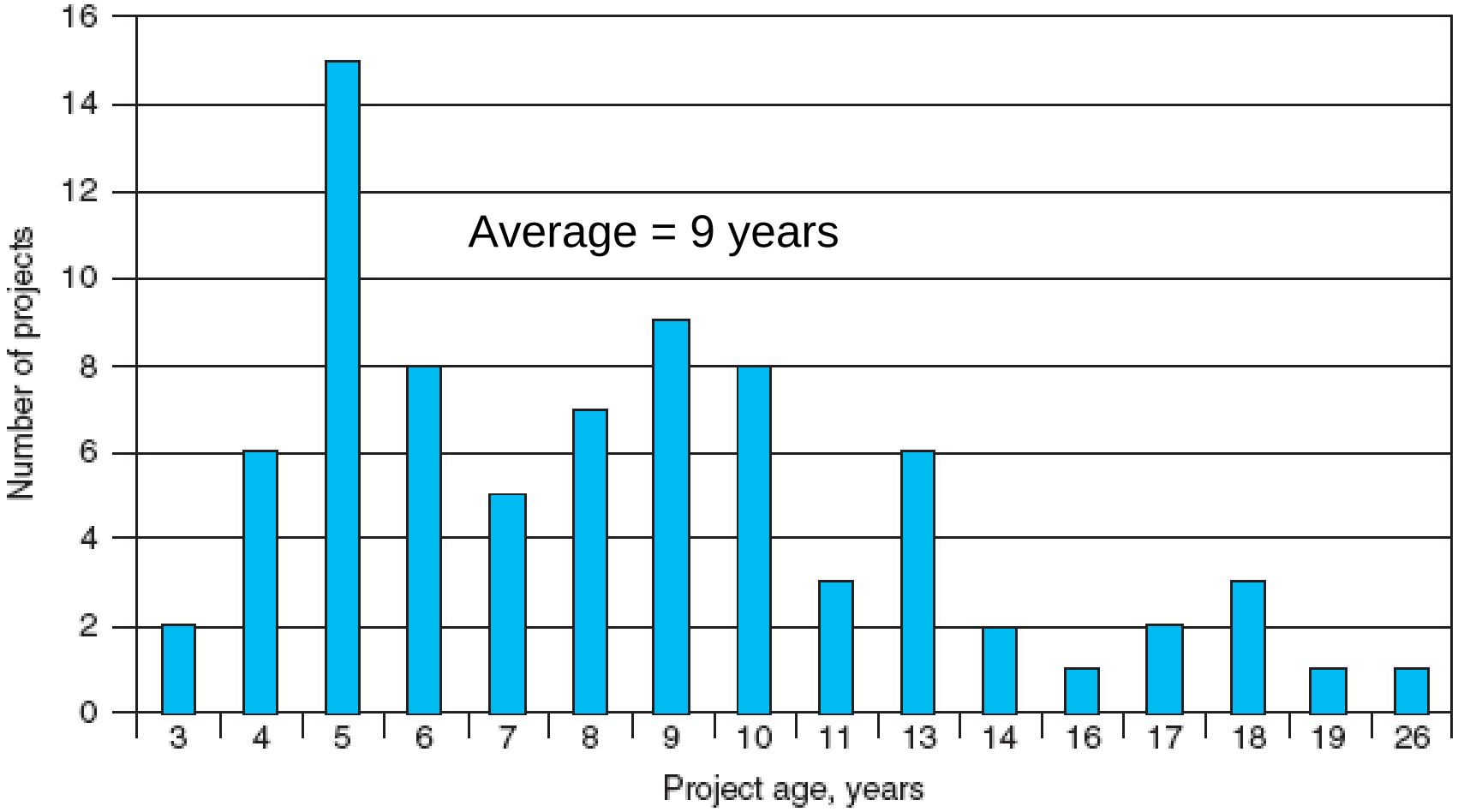
PCA Funded Project

- Study conducted in 2005
- Identified candidate project sites in concert with PCA
  - State (DOT), County, City Agencies, Private
- Interaction with select officials
- Visual Pavement Condition Index (PCI) survey
- Extracted roadway cores for UCS measurements

Performance Evaluation

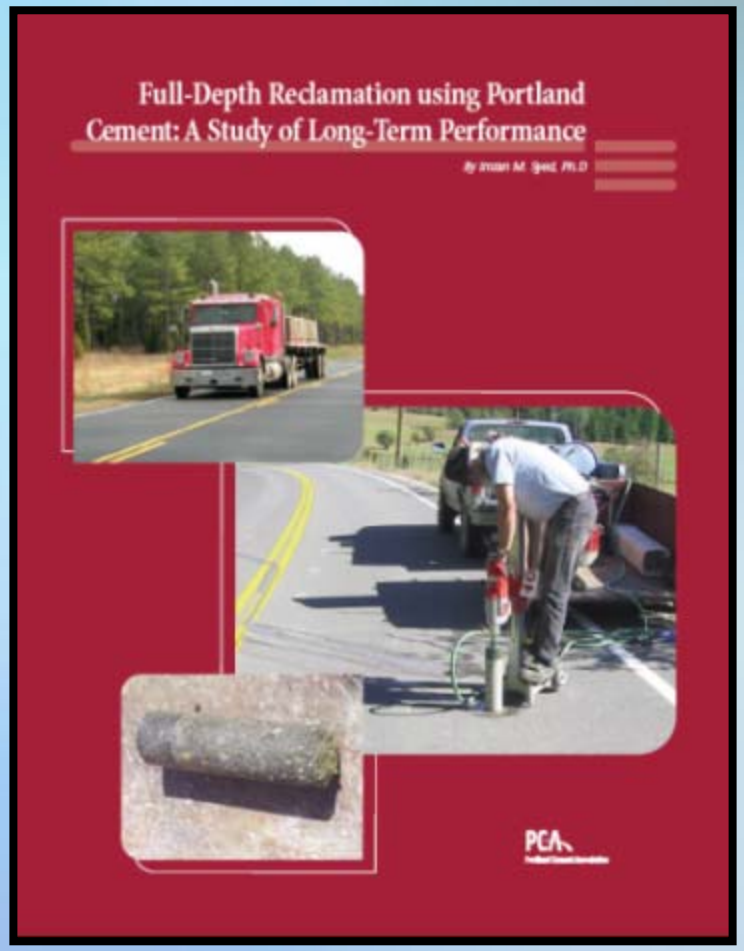


79 Projects Studied



LTP Study Conclusions

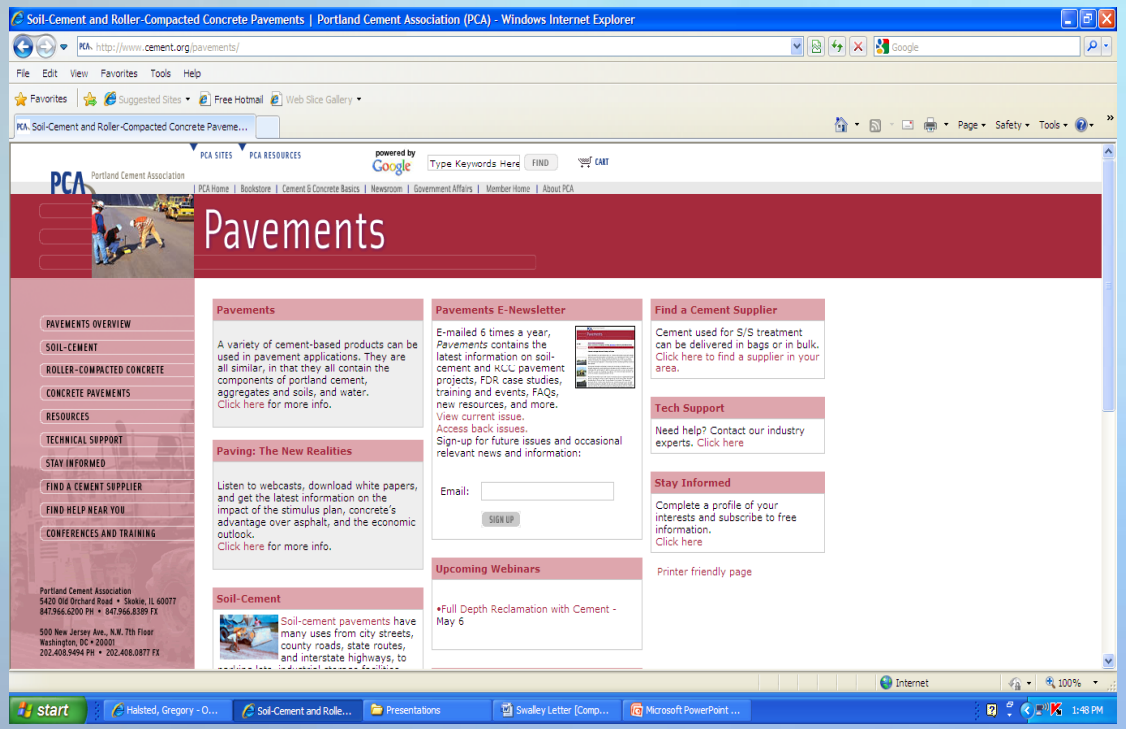
- Overall, excellent LTP
- Average PCI of 89
- UCS of cores 260 to over 1,000 psi
- Cement contents 2 to 12 percent with average being 5 percent
- Most surface distress was in the asphalt layer
- No major failures attributed to the cement-stabilized base
- Owners are happy with



Concluding Comments

- Use of in-place materials
- Very sustainable process
- Fast operation
- Constructed under traffic
- Structurally better than granular base
- Can apply local traffic almost immediately
- 30 to 60 percent less expensive than removal and replacement

For more on full-depth reclamation, visit the PCA website at www.cement.org/pavements



Questions?

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