In-Place Recycling
Full Depth Reclamation (FDR)
Mix Design and Quality Control
FDR Mix Designs and Quality Control Practices Overview
Mix Design
FDR
GDOT –
FDR Specifications

301 - Soil Cement Construction
316 – Cement Stab Reclaimed Base Const.
412 - Bituminous Prime
814 - Soil Base Materials
821 - Cutback Asphalt
824 - Cationic Asphalt Emulsion
830 - Portland Cement
880 - Water
FDR Mix Design

-Sample Roadway / Pavement - Strategy

-Determine Additive -- Additional Strength

-Estimate Additive
  • Generally 3 – 7 Percent
  • Based on Dry Material Weight

-Perform Sample Fabrication
  • Prepare Proctor Samples
  • Use Four or Six Inch Mold

-Perform Strength Testing
Obtaining Materials – Sampling

Thing to Think About…..

Where Do I Sample?

- Design Depth
- Good Areas
- Bad Areas
- Cuts / Fills
- Drainage / Good or Bad –
  (Water, Water, Water)
  (Drainage, Drainage, Drainage)
Obtaining Inplace Materials – Sampling

Thing to Think About….. (CON’T)

Where Do I Sample? (con’t)

- Obvious Distress Change
- Shoulder Widening
- Other Areas of Different Structure
- Random and Representative
- Subgrade Conditions
Pre-Sampling / Pre-Coring

• Cutting Cores
  1. Every Street
  2. Every 500 Feet Per Lane
  3. Check for Asphalt Depth and Base Type
  4. Typically 4 inch cores

• Inspect bad areas (patches, concrete)

• Ensure Layer Consistency

• Determine the Potential Number of Mix Designs Required
Pre-Sampling / Pre-Coring

Sampling (con’t)

• Consistency
• Change in Pavement Distress
• Change in Width
• Fill Sections
• Cut Sections
• Other obvious roadway features
Pre-Sampling

Typical Mix Design -

-Design Depth Rule of Thumb 50/50

-Old Road - well proven pavement structure

-New Road - may need more sampling and testing -

-Water / Water / Water

-Compaction / Compaction / Compaction

How Often to Sample

-Every 6,000 to 12,000 Square Feet of Pavement for ALL Pavements, Roads, Parking Lots, Etc.
How to Sample Roadways

- Consider Rehabilitation strategy
- Core and Remove Pavement (Core) and Place in bag / bucket with Base and Subgrade Soil
- Typically 6 inch cores
- 100 ways to skin a cat
- Random and Representative
- Sample – use parallel sides of hole to ensure proper proportioning to the design depth
- Sample for Moisture (optional)
Additional Materials to Consider

Add - Mixtures

- **Portland Cement**
- Emulsions
- Rejuvenators
- Lime
- Lime Kiln Dust
- Foamed Asphalt
- Lime and Other
- Portland Cement and Other
- Coarse Aggregate
- Fine Aggregate
- Other Combinations
<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Well-graded gravel</th>
<th>Poorly graded gravel</th>
<th>Silty gravel</th>
<th>Clayey gravel</th>
<th>Well-graded sand*</th>
<th>Poorly graded sand</th>
<th>Silty sand</th>
<th>Clayey sand</th>
<th>Silt, Silt with sand</th>
<th>Lean clay</th>
<th>Organic silt / organic lean clay</th>
<th>Elastic silt</th>
<th>Fat clay, fat clay with sand</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USCS</strong></td>
<td>GW</td>
<td>GP</td>
<td>GM</td>
<td>GC</td>
<td>SW</td>
<td>SP</td>
<td>SM</td>
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<td>MH</td>
<td>CH</td>
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<tr>
<td>AASHTO</td>
<td>A-1-a</td>
<td>A-1-b</td>
<td>A-1-b</td>
<td>A-1-b</td>
<td>A-3 or A-1-b</td>
<td>A-2-4 or A-2-5</td>
<td>A-2-6 or A-2-7</td>
<td>A-4 or A-5</td>
<td>A-6</td>
<td>A-4</td>
<td>A-5 or A-7-5</td>
<td>A-7-6</td>
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<tr>
<td><strong>Fortress® FDR / GBS</strong></td>
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<td></td>
<td></td>
<td>Project / material selection, engineered mix design/emulsion, same day return to traffic, quick overlay</td>
<td>Cannot handle high clay content</td>
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<tr>
<td><strong>Foamed asphalt</strong></td>
<td>P200 10 to 20% and follow max. density grad.</td>
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<td></td>
<td>Same day return to traffic, quick overlay</td>
<td>Safety, may require cement / lime, gradation sensitive, maintain high asphalt temperature</td>
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<tr>
<td><strong>Portland cement</strong></td>
<td>PI&lt;10</td>
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<td></td>
<td>Quick set, high strength, compatible with many soils</td>
<td>Prime and sand req’d for traffic, dust, early cracking, little overlay bonding</td>
<td></td>
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<tr>
<td><strong>Lime</strong></td>
<td>PI&gt;10 and P200&gt;25 or PI 10-30 and and P200&gt;25, SO4 in clay &lt; 3000 ppm</td>
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<td></td>
<td>Quick set, high strength (with clay-containing soils)</td>
<td>Dust, early cracking, potential sulfate heave</td>
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<tr>
<td><strong>Lime plus cement</strong></td>
<td>PI&gt;30 and P200&gt;25%</td>
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<td>Same as lime</td>
<td>Same as lime</td>
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</tbody>
</table>

*Some projects that do not meet these material recommendations have been successfully built
GDOT Test Methods

GDT – 19  Determining Maximum Density of Soil-Cement Mixtures

GDT – 20  Determining Field Density of Soils with <45% Retained on the No. 10 Sieve and <10% Retained on the 1-Inch Sieve

GDT – 21  Determining Field Density of Soils with >45% Retained on the No. 10 Sieve and >10% Retained on the 1-Inch Sieve

GDT – 59  Testing Density of Roadway Materials with Nuclear Gauge
| GDT – 65 | Laboratory Design of Soil-Cement and Cement Stabilized Graded Aggregate |
| GDT – 67 | Family of Curves Method for determining Maximum Density of soils |
| GDT – 86 | Determining the compressive strength of Cement Stabilized Base cores taken from the roadway |
Moisture/Density Relationship

- Moisture Content
- Dry Density (lb/cf)
- Maximum Dry Density
- Optimum Moisture Content
Performance Strength Testing

![Graph showing the relationship between strength and performance levels](image)
Test For Strength

- **Unconfined Compressive Strength Testing**
  - Used in developing the mix design in the lab
  - 7-day strengths ranging from 300 psi to 400 psi (2.1 MPa to 2.8 MPa) are generally recommended
  - Proven to increase structural capacity to handle existing and future traffic loads
  - Proven to be durable in both wet/dry and freeze/thaw environments
  - Used in controlling the quality of work
Comprehensive Strength vs % Cement

ABC Avenue
Somewhere, Georgia

Unconfined Compressive Strength vs. % Cement - 04/25/2017

123 Lane
Somewhere, Georgia

Compressive Strength vs. % Cement
Quality Control - Construction
Gradation
Spread Rate/Yield
+/- 1.0% Liquid
+/- 5.0% Granular
Length, width, depth
vs. gallons/tons used
Density / Moisture
Compaction! Compaction! Compaction!
Thickness

Cement Content (Phenolphthalein)
Proofroll With Loaded Truck

Stability-Strength
Don’t Remove and Replace Already Paid for Material (R&R)

REUSE IT
In-place Recycling (FDR)