Full Depth Reclamation (FDR) Overview

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1. What is FDR?
2. Recycling overview
3. Pavement assessment
4. Construction and materials
5. Surface overlays / pavement design
6. Longevity factors
7. Economic Assessment
8. Summary
Full Depth Reclamation (FDR) is a pavement rehabilitation technique in which the full flexible pavement section and a predetermined portion of the underlying materials are uniformly pulverized and blended together to produce a homogeneous stabilized base course.
Operational Schematic

- Deep recycled layer
- Injection of water and/or fluid stabilizing agents
- Operating direction
- Milling drum
- Distressed pavement
- Granular material

(COLAS Solutions logo)
Primary stabilizing methods

- Pulverization only
- Mechanical stabilization
- Bituminous stabilization
- Chemical stabilization
Why recycle?

Correct pavement defects
Increase structural capacity
Geometry – Limited elevation rise or limited width
Reuse valuable resources
Economics
Reduce environmental impact
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Overview

• Full Depth Reclamation uses bituminous products (CSS-1 or -1h, foamed AC) or cement / fly ash

• Through asphalt layer and into the base

• Grinding full depth in first pass then 2nd pass add and mix product.

• Grade, compact and seal after cure.
Some benefits of FDR

With proper design and process selection; cross-slope and/or profile grade adjustments/corrections can be made.
Some benefits of FDR

Pavement widening can easily be accomplished.
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Pavement Assessment

Visual inspection

– Defects and features to look for
  • Common distresses addressed – Rutting, cracking (block, fatigue, reflective) – understand the cause and how deep (subgrade)
  • Drainage
    – Water have unobstructed access to drains / ditch?
    – Are ditches present, deep enough, clogged?
    – Inadequate drainage will create problems.
Pavement Assessment

Visual inspection

– Coring / sampling for visual assessment
– Defects and features to look for
  • Edge support
    – Are shoulders and ditches adequate?
  • Pavement width
    – If the pavement will be widened, is there sufficient thickness, or will new material be used?
  • Patches
    – Patches are often an indication of a subgrade problem.
Pavement Assessment

Visual condition survey:
- Cracking, rutting, aging, ride, signs of subgrade deterioration

- Coring / layer depth check*
  - Observe signs of stripping
  - Consider dynamic cone penetrometer (DCP)

- Falling weight deflectometer (FWD) – existing structural properties
  - Ground penetrating radar (GPR) – existing layer thicknesses

Coring / layer depth check*

Functional distress

- Minor surface distress
  - Crack filling, Micro surfacing / slurry seal, Chip seal, FiberMat, Ultrathin bonded wearing course

- Wide cracks or excessive cracking / aging
  - CIR with appropriate wearing course

- Soil appropriate for traffic and road needs
  - FDR with appropriate wearing course

- Soil not appropriate
  - Soil stabilization with appropriate base and asphalt layers

Structural distress or improvements needed
Typical Pavement Deterioration and preservation or treatment method

Time, years

Condition

Excellent
Good
Fair
Poor
Very poor
Failed

Fog seal
Chip seal
Micro surfacing
Thin overlay / HIR
Ultra-thin bonded
Mill & fill or HIR
Cold in-place recycle
Full depth reclamation
Reconstruct
Candidate?
Candidate?
Typical FDR Candidate

- Asphalt pavement with good drainage with side ditches or an internal drainage structure

- Asphalt pavement over aggregate base or stabilized base
  - Could be an existing gravel road with adequate thickness of material over the subgrade

- Very worn asphalt pavement with medium to high severity cracks going through entire asphalt layer

- Asphalt pavement with signs of rutting, fatigue cracking, or patches
  - If bituminous, not due to structural distress related to the subgrade
FDR Candidates

- Parking lots
- Low to high volume roads
- City streets with curbs
- Shoulders
- Interstate highways
- Airports
• Cement FDR (CRABS) – since 1993
• Statewide over 3000 miles – Interstates and state routes
• Performed because:
  • Inadequate base thickness
  • Non-uniform construction
  • Inadequate drainage
  • Excessive thickness of plant mix
  • Curb and gutter
  • Depleting good quality materials sources
Emulsion FDR – since early 2000’s

- Gravel roads
- City streets
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FDR Equipment

• Road reclaimer (CAT, CMI/Terex, Wirtgen)
• Grader
• Dry chemical distributors
• Water trucks
• Emulsion / hot AC trucks
• Compactors
  – Vibratory padfoot roller
  – Pneumatic roller (for bituminous)
  – Vibratory static steel drum (finish)
FDR Process

• Spread add-stone in front of reclaimer, if any
• Pre-pulverize the bituminous surface at the specified depth (6”-12”) while adjusting moisture content (under OMC bituminous; over OMC cement)
• Shape pulverized material to proper grade and cross slope
• Compact lightly to avoid moisture loss / carry traffic for short time (if necessary)
• Spread dry additive if required
• Perform pass at specified depth while mixing bituminous product; water also added if needed
• Compact with padfoot roller and
• Remove pad marks and shape with grader
• Final compaction
FDR Process

Road before pulverization

Pulverization and water addition (shaping if needed)

Cement or rock addition
FDR Process

- Emulsion addition or cement mixed (3 to 4 hour working window with cement)
- Padfoot rolling until walkout
- Shave padfoot marks and final grading
FDR Process

Final compaction
(often in combo with pneumatic)

Completed FDR
Curing

• Allow recycled mix to cure
  – Bituminous
    • Higher water to start will take longer to cure
    • Small quantity of cement used during construction reduces curing time
  – Cement – Keep moist during curing

• Some state spec max. moisture content or number of days before overlay
  – Recommend maximum 50% of lab Modified Proctor OMC, as measured from in-place field sample (bituminous); must be firm
  – A few days to a week for cement
FDR Alternatives

• CIR - ???
  • Don’t perform CIR when FDR should be

• Reconstruction
FDR Additives

- Emulsion: 1-5 % (60 to 65% residue)
- Foamed Asphalt: 0.75-3 %
- Cement: 3-6 %*
  *0%-1.5% if used in combination with bituminous stabilizers
- Lime Kiln Dust (LKD): 4-8 %

- Air voids are typically high – range of about 8 to 15+ percent
**Additives for Various Full Depth Reclamation Materials**

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<thead>
<tr>
<th>AASHTO</th>
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<th>Poorly graded gravel</th>
<th>Silty gravel</th>
<th>Clayey gravel</th>
<th>Well-graded sand</th>
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<th>Elastic silt</th>
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*For the blend of all recycled layers*
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Moisture content in the recycled mix must be low enough before recycled layer is covered:

- HMA binder and wearing courses
- Surface treatments – chip seal (double seal highly recommended)
- Dense-graded cold mixes

Bonding of any treatment is very important!
Pavement Design

- Typical structural coefficients – Each agency determines layer coefficients (by experience) – Units of 1/inch
  - FDR:
    - Cement: 0.14 to 0.20 (0.15 typical) – though stiffer, has lower coefficient
    - Bituminous: 0.20 to 0.28 (0.25 typical)
    - Mechanical: Treat as aggregate base
  - Aggregate base
    - 0.08 to 0.12 (0.11 typical)

- Note: 1993 pavement design guide to be replaced by MEPDG methodology
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Longevity Factors

- Local conditions
- Climate
- Quality of materials
- Workmanship
- Affordability
- Proper project selection and design
Longevity Factors

- **FDR with surface treatment**: 7 to 10 years
- **FDR with HMA treatment**: Up to 20 years
- **CIR with surface treatment**: 6 to 8 years
- **CIR with HMA treatment**: 12 to 20 years
- **Surface treatment**: 1 to 7 years
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Economic Assessment

FDR - Initial cost savings of 25% to 33% or higher compared to the cost of reconstruction have been observed.
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Summary

• Project selection
  – Distresses not excessive for the treatment
  – Drainage! Can’t be over-emphasized.

• Investigation and Sampling
  – Design samples must represent the width and length and material changes of the project
Summary

• Materials
  – New aggregate or RAP for material improvement or depth improvement / widening can overcome material deficiencies
  – Dealing with fabric

• Construction
  – All personnel – agency, prime, sub-contractor, material suppliers - review expectations and review processes prior to project
  – Calibrated equipment and double check
  – Added water
  – Compaction equipment, methods of control, and acceptance
  – Weather: Rain and freezing temperatures
  – Traffic release
  – Curing and overlay time
Summary

• Recycling works and has a proven track record
• Reduces costs and time
  – 25-33% or more savings
  – ½ to 1/3 the time of reconstruction
• Conserves energy
  – 50-70% reduction
• Conserves resources by using existing, in-place materials (often high quality)
• Eco-friendly by reducing the use of fossil fuels
Thank you

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