Full Depth Reclamation (FDR) Overview

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Outline

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

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FDR Definition

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.

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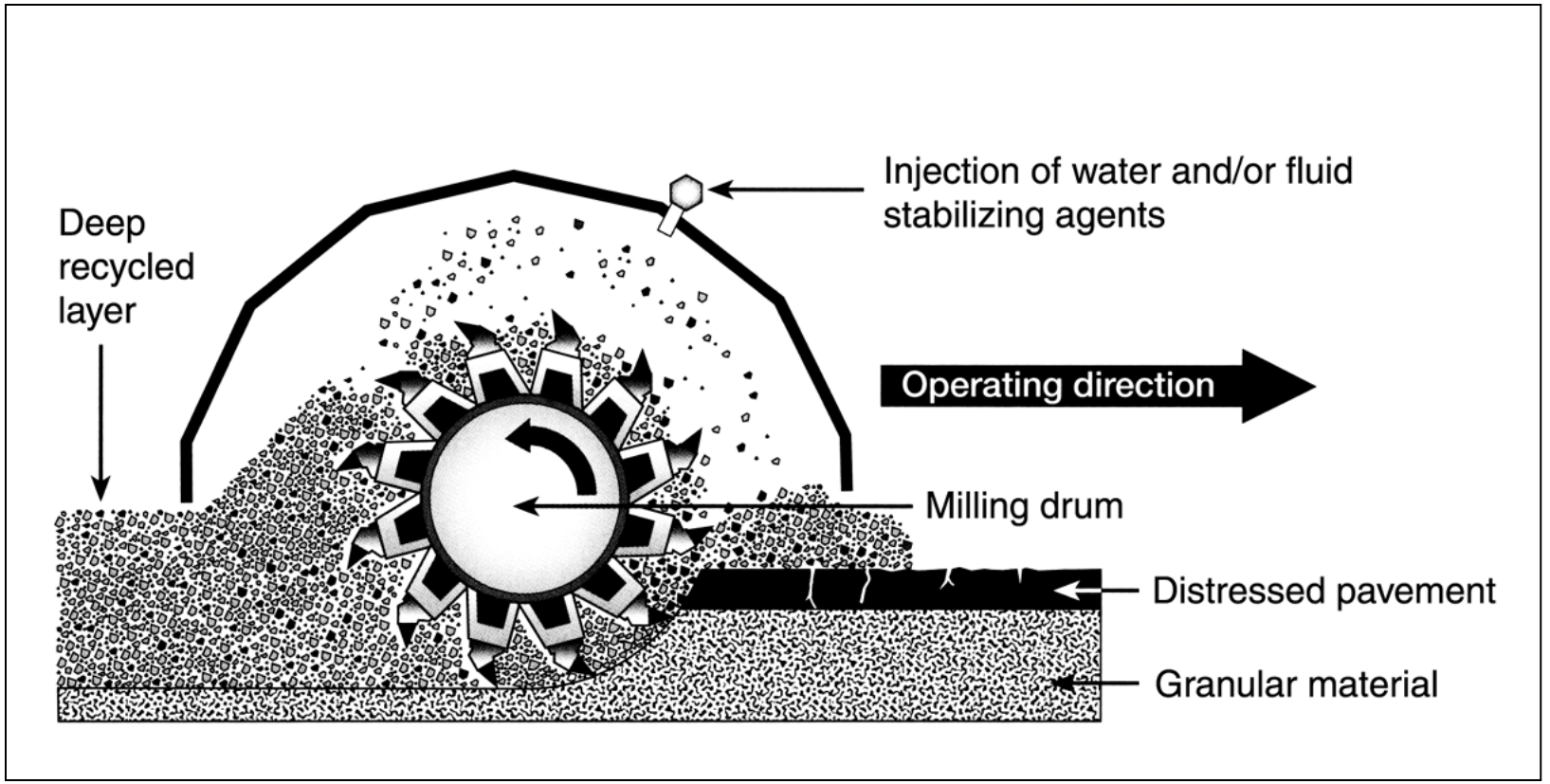
Operational Schematic



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Full Depth Reclamation

Primary stabilizing methods

- Pulverization only
- Mechanical stabilization
- Bituminous stabilization
- Chemical stabilization

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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.

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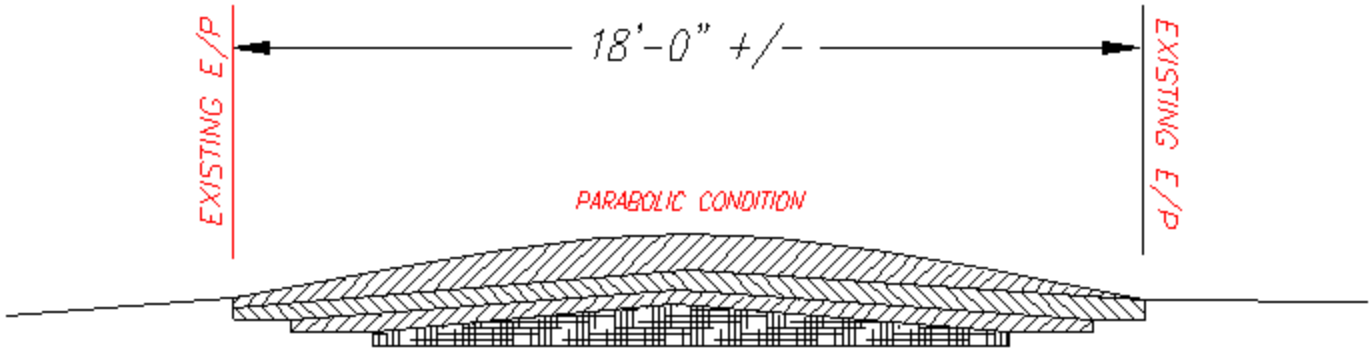
Some benefits of FDR

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



EXISTING SECTION (BEFORE FDR)

PROPOSED SECTION (AFTER FDR)

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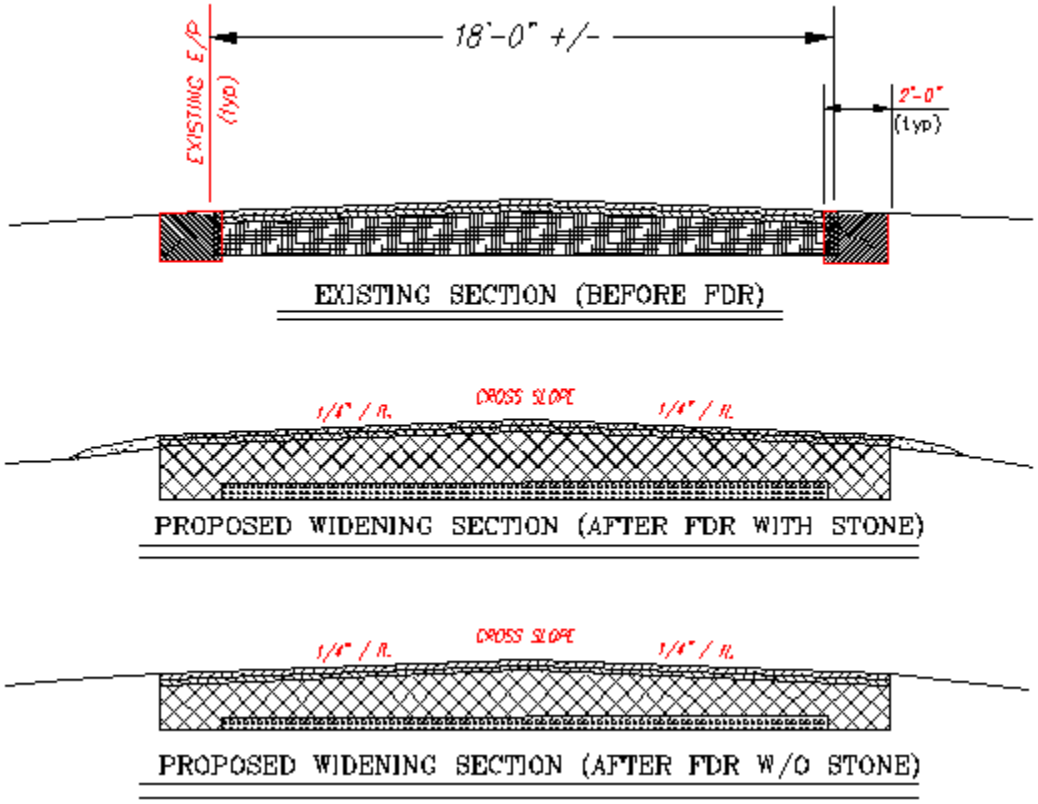
Some benefits of FDR

Pavement widening can easily be accomplished.



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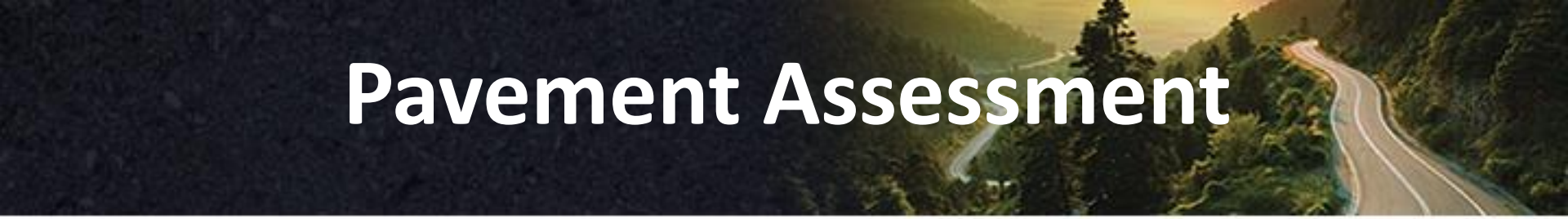
Pavement Assessment



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.

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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.

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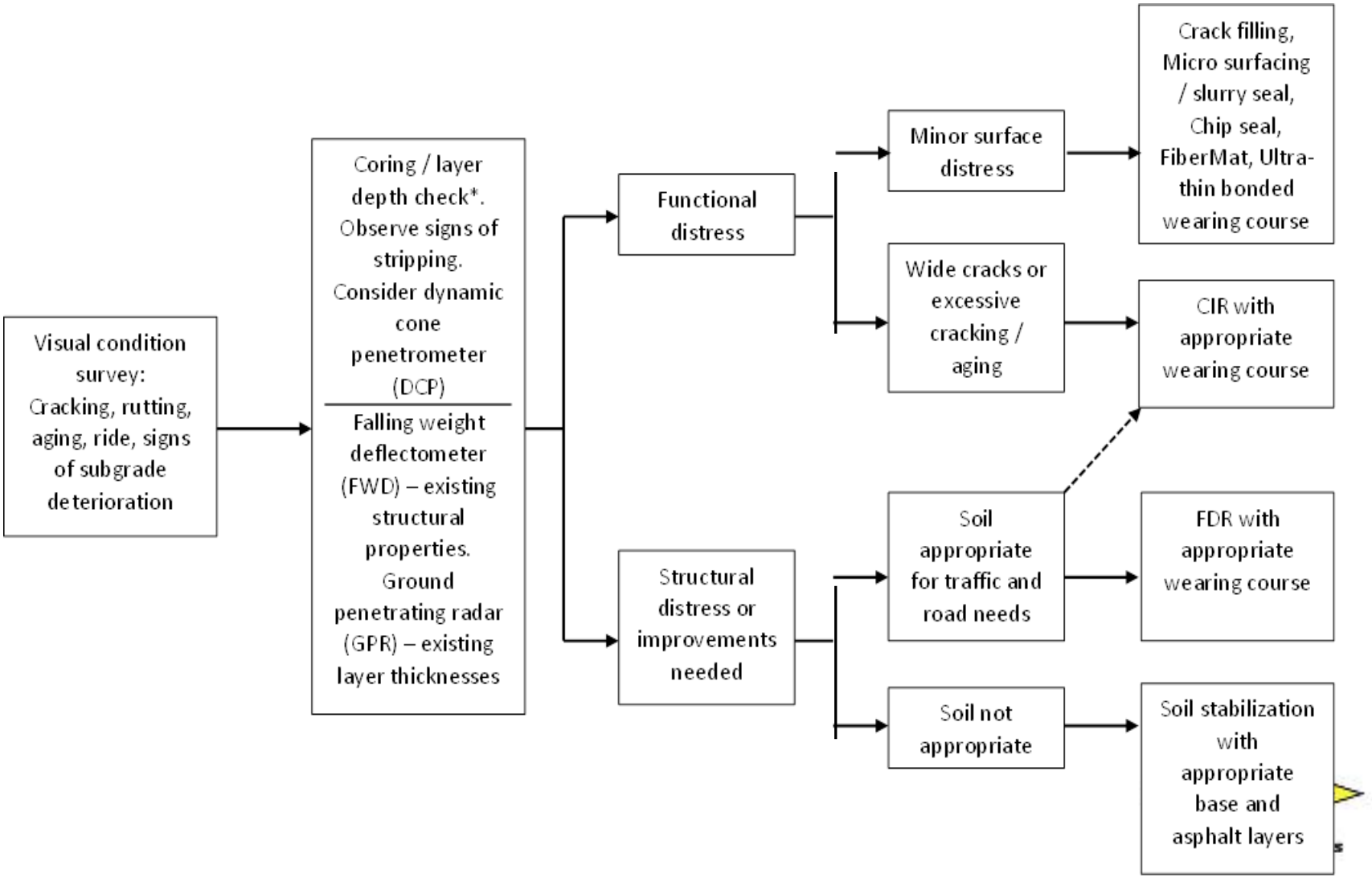
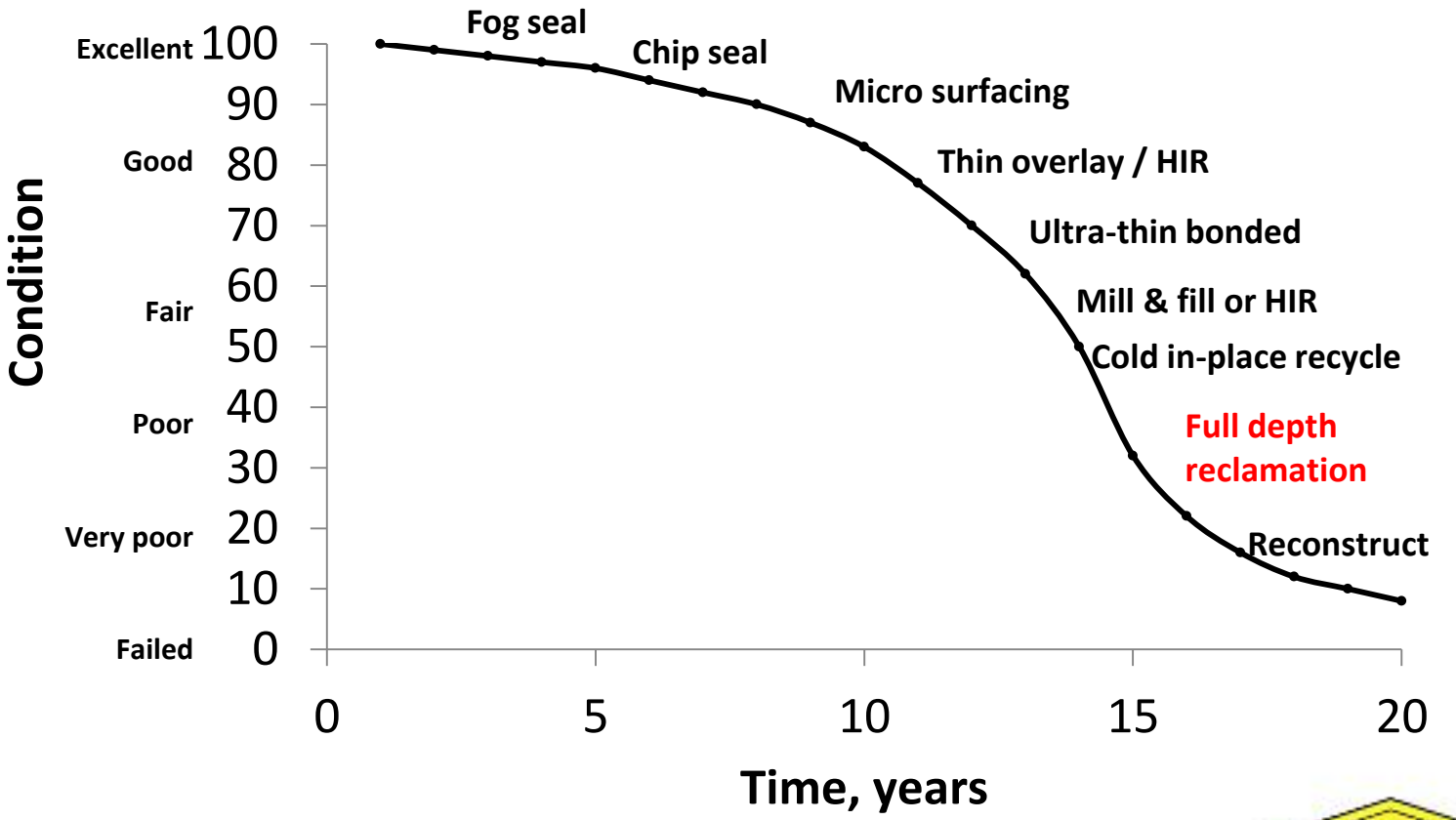
Pavement Assessment



Typical Pavement Deterioration and preservation or treatment method



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Candidate?

?

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Candidate?

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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

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FDR Candidates

- Parking lots
- Low to high volume roads
- City streets with curbs
- Shoulders
- Interstate highways
- Airports

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Idaho DOT

- 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

Minnesota Counties and Cities

- 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)

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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

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FDR Process

Road before pulverization

Pulverization and water addition (shaping if needed)

Cement or rock addition

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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

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FDR Process

Final compaction (often in combo with pneumatic)

Completed FDR

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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

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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

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FDR and Soil Stabilization Additives

Additives for Various Full Depth Reclamation Materials*

		Well-graded gravel	Poorly graded gravel	Silty gravel	Clayey gravel	Well-graded sand	Poorly graded sand	Silty sand	Clayey sand	Silt, Silt with sand	Lean clay	Elastic silt	Fat clay, fat clay with sand
	AASHTO	A-1-a	A-1-a	A-1-b	A-1-b or A-2-6	A-1-b	A-3 or A-1-b	A-2-4 or A-2-5	A-2-6 or A-2-7	A-4 or A-5	A-6	A-5 or A-7-5	A-7-6
	USCS	GW	GP	GM	GC	SW	SP	SM	SC	ML	CL	MH	CH
Full Depth Reclamation	Emulsion FDR SE > 30 or PI < 6 and P200 < 20	■	■	■	■	■	■						
Full Depth Reclamation	Foamed asphalt SE > 30 or PI < 6 and dense gradation	■		■	■	■							
Full Depth Reclamation	Portland cement PI<12 and RAP < 50%	■	■	■	■	■	■	■	■	■	■		
Soil Stabilization	Lime PI>10 and P200<25 or PI 10-30 and and P200>25, SO_4 in clay < 3000 ppm								■		■	■	■

*For the blend of all recycled layers

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Surface Courses

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!

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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

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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

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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

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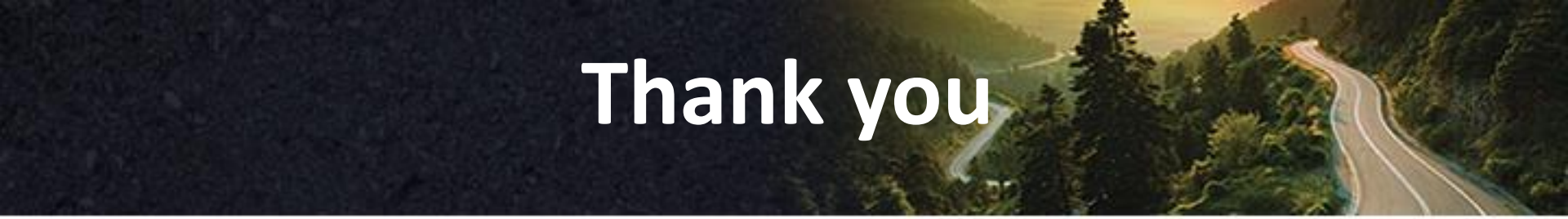
Thank you



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