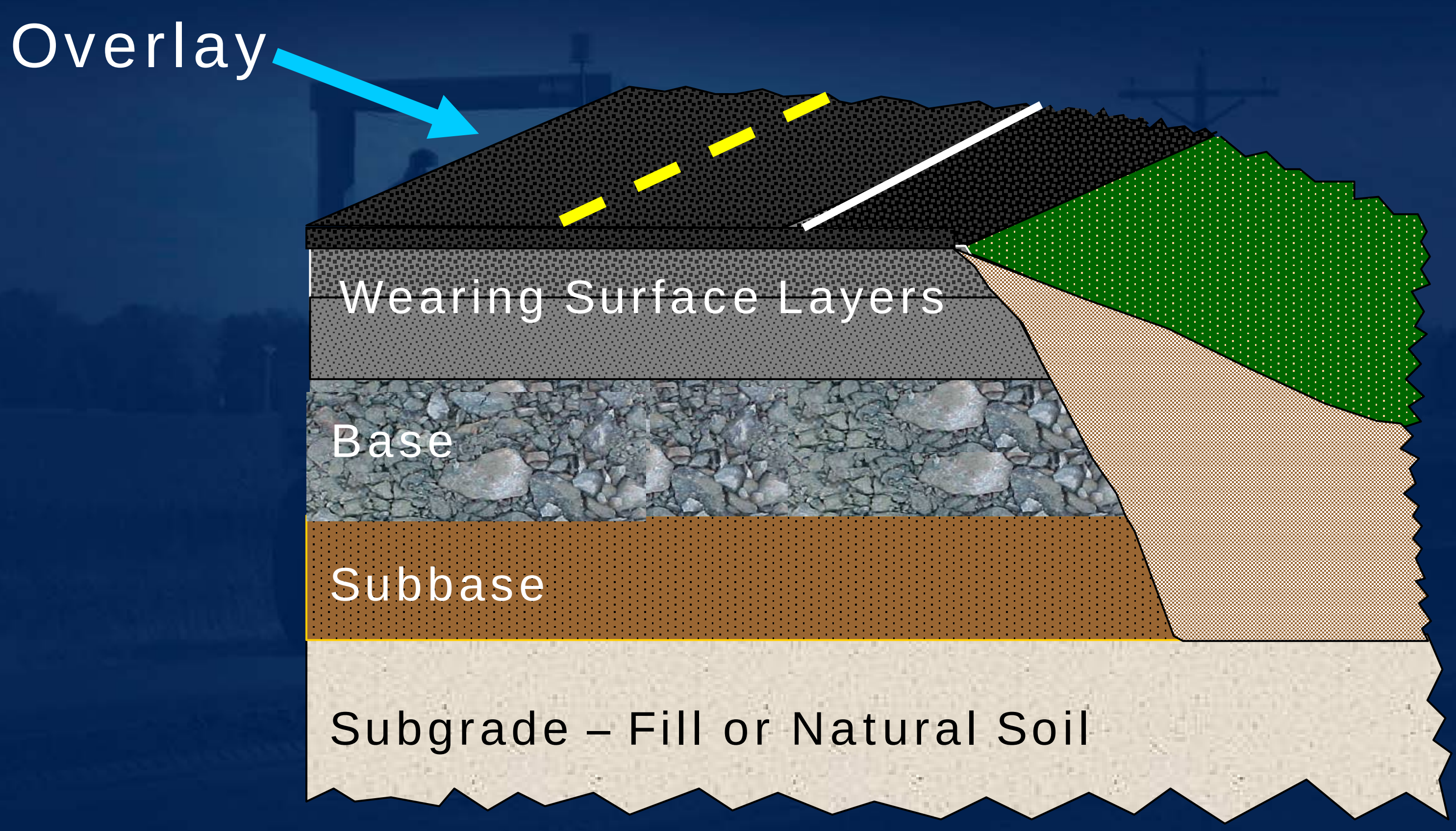
Pavement Rehabilitation Selection
Rehabilitation Techniques

Bituminous Pavement Rehabilitation Techniques

- Overlays
  - Bituminous
  - Concrete
  - Pre-overlay Treatments
  - Mill and Overlay
  - Mill and Inlay
- Recycling Options
  - Cold In-place Recycling
  - Full-Depth Reclamation
    - Pulverization
    - Stabilization
- Pavement Reconstruction

Overlays

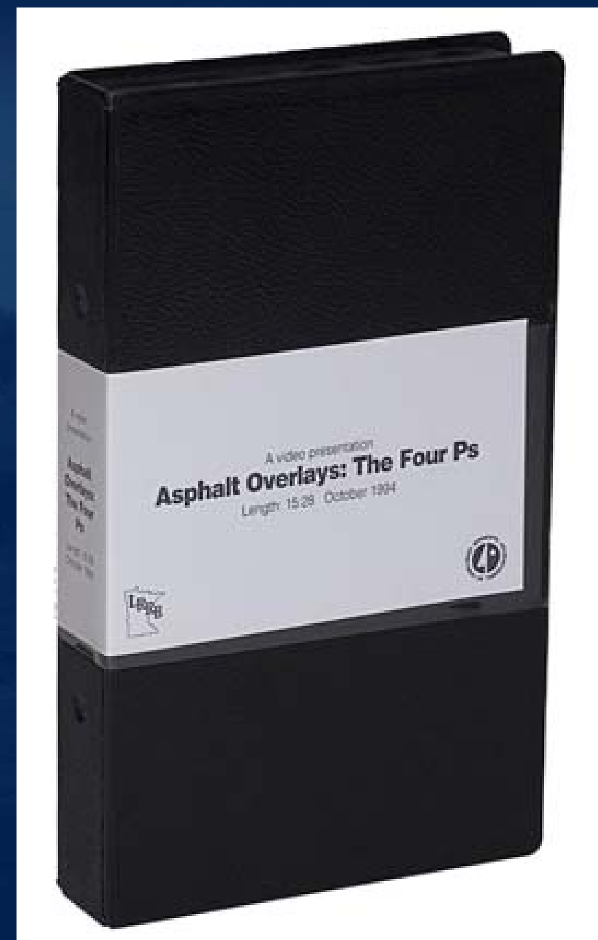

Overlay
Wearing Surface Layers
Base
Subbase
Subgrade – Fill or Natural Soil

Overlays
What is an Overlay?

- Placement of a new course of pavement on the remaining pavement structure
  – Bituminous or Concrete
  – Mill and Overlay/Inlay

Overlays
Fundamentals of Overlays

- Planning
  - Selection of overlay type
- Preparation
  - Crack and joint repair
  - Pothole patching
  - Rut filling (minor)
  - Milling
- Production
  - Mix design
- Placement
  - Traffic control
  - Tack coat
  - Density



Bituminous over Bituminous Overlays
What is a BOB Overlay?

- A new bituminous surface is paved over an existing bituminous pavement.
- Can be a non-structural or structural overlay:
  - Non-structural overlay
    - Generally used as a short-term fix
  - Structural overlay
    - Thicker mat that will increase pavement strength

Bituminous over Bituminous Overlays
Fundamentals of BOB Overlays

1. Pavement Evaluation
2. Resurfacing Design
   - Resurfacing Thickness
     - Typically 1.5 - 3 inches on low volume roads and as a non-structural overlay on primary roads
     - Typically 3 - 6 inches as a structural overlay on primary roads
   - Transverse crack treatment
   - Mixture Design
   - Drainage Design

Bituminous over Bituminous Overlays
Fundamentals of BOB Overlays

3. Pre-resurfacing Work
   - Pre-surface Repairs
     - Pothole patching
     - Crack repair
   - Direct Placement or Milling

Bituminous over Bituminous Overlays
Fundamentals of BOB Overlays

- Direct Placement or Milling
  - Direct placement when all the following are true:
    - Additional structure is necessary
    - No issues with existing pavement materials
    - No vertical limitations
  - Mill when one or more of the following is true:
    - Additional structure is not required
    - Problems with existing pavement materials
    - Vertical limitations exist

Bituminous over Bituminous Overlays
Fundamentals of BOB Overlays

4. Construction
   - Surface cleaning
   - Tack Coat
     - Different rates for milled and non-milled surfaces
   - Bituminous Placement
     - Lift thickness
     - Density control

Bituminous over Bituminous Overlays
Applications for
Non-structural BOB Overlays

- Good Candidates include pavements with:
  - Good subgrade, base and cross-section
  - Adequate strength
  - Where a short term fix is acceptable
- Poor Candidates include pavements with:
  - Poor subgrade and/or base support
  - Significant surface distresses

Bituminous over Bituminous Overlays
Applications for Structural BOB Overlays

- Good Candidates include pavements with:
  - Good subgrade and base, but inadequate thickness
  - Marginal structure, but cannot be closed to traffic
- Poor Candidates include pavements with:
  - Poor subgrade and/or base support that cannot be overcome with a thick overlay
  - Frost issues

Concrete over Bituminous Overlays
What is a COB Overlay?

- A new concrete surface is paved over an existing bituminous pavement
- Typically used as an unbonded overlay (≥4”)
- Can be bonded or unbonded
  - For unbonded overlays, degree of bond is not considered in design

Concrete over Bituminous Overlays
Fundamentals of COB Overlays

1. Pavement Evaluation
2. Resurfacing Design
   - Resurfacing Thickness
     - Typically 6 – 11 inches on high volume roads
     - Minimum of 4 inches on low volume roads
   - Mixture Design
   - Joint Design
   - Drainage Design
   - Edge support considerations

Concrete over Bituminous Overlays
Fundamentals of COB Overlays

Unbonded resurfacing thickness	Maximum transverse joint spacing
< 5 in. (12.7 cm)	6 x 6 ft (1.8 x 1.8 m) panels
5–7 in. (12.7–17.8 cm)	Spacing in feet = 2 times thickness in inches
> 7 in. (17.8 cm)	15 ft (4.6 m)

Source: Guide to Concrete Overlay Solutions

Concrete over Bituminous Overlays
Fundamentals of COB Overlays

3. Pre-resurfacing Work
   - Pre-surface Repairs
   - Direct Placement or Milling
     - Direct placement when rutting < 2”
     - Mill when rutting ≥ 2”
     - Mill 1” - 2”, leaving < 1” of the rutting
   - Surface cleaning

Concrete over Bituminous Overlays
Fundamentals of COB Overlays

Existing pavement distress	Spot repairs to consider
Fatigue cracking	Full-depth repair patch
Pothole	Full-depth repair patch
Deep rutting	Milling
Shoving, slippage	Milling
Thermal cracking	None

Source: Guide to Concrete Overlay Solutions

Concrete over Bituminous Overlays
Fundamentals of COB Overlays

4. Construction
   - Dowel Bars (when needed)
   - Concrete Placement
   - Curing
   - Joint Sawing

Concrete over Bituminous Overlays
Equipment and Materials for COB Overlays

- Equipment needed:
  - Conventional concrete paving equipment
  - Conventional asphalt paving equipment (if needed for pre-overlay repairs)
  - Milling machine
- Materials needed:
  - Conventional concrete materials
  - Conventional or open-graded asphalt materials (if needed for pre-overlay repairs)
  - Concrete anchorages to secure dowel baskets

Concrete over Bituminous Overlays
Considerations for COB Overlays

- Original roadway width
- Vertical clearance
- Number of culverts and bridges
- Drainage
- Materials
- Schedule
- Traffic

Concrete over Bituminous Overlays
Applications for COB Overlays

- Good Candidates include pavements with:
  - Adequate subgrade support, but inadequate pavement structure
- Poor Candidates include pavements with:
  - Vertical geometry restrictions
  - Significant frost issues
  - Cannot be closed to traffic

Pre-overlay Treatments for Bituminous and Concrete Overlays

Pre-overlay Treatment Considerations:

- What are the existing pavement issues?
  - Structural issues verses surface distresses
- What is the required permeability of the treatment?
- What is the required ease of construction?
  - Pre-overlay Treatment
  - Bituminous or Concrete Overlay
- What are the costs?

Pre-overlay Treatments for Bituminous and Concrete Overlays

- Pre-overlay treatments include:
  - Milling
  - Blade Leveling/Tight Blading
  - Localized Structural Repairs
  - Flexible Slurry
  - Grids/Fabrics
  - Stress Absorbing Membrane Interlayer

Pre-overlay Treatments for Bituminous and Concrete Overlays

- Milling
  - Eliminates material problems and significant condition issues that may be cost prohibitive to fix before the overlay
  - Allows you to maintain the same roadway elevation
  - Removes surface distresses before structural overlay

Mill and Overlay

- Generally used with vertical restrictions or to correct severe surface defects
- Mill and overlay may increase the overall pavement height slightly
  - i.e. Mill 3”, Overlay 4”

Mill and Inlay

- Also used with vertical restrictions or to correct severe surface defects
- Maintains the same overall pavement height
  - i.e. Mill 3”, Overlay 3”
- Keep existing shoulders and/or curb

Pre-overlay Treatments for Bituminous and Concrete Overlays

- Blade Leveling/Tight Blading
  - Should be done in two passes
    - One in each direction
  - Fine dense graded sand mix with high AC (asphalt concrete) content
  - Pneumatic roller should be used for compaction
  - Typically < 1” thick

Pre-overlay Treatments for Bituminous and Concrete Overlays

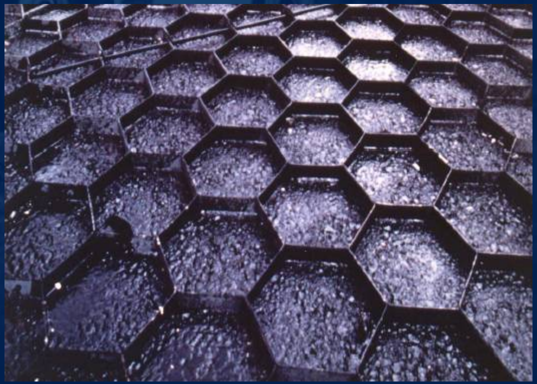
- Localized Structural Repairs
  - Sometimes requires base and/or subgrade correction
  - Address the root cause, not the symptom
    - Inadequate structure
    - Drainage
    - Contaminated base

Pre-overlay Treatments for Bituminous and Concrete Overlays

- Flexible Slurry
  - Alternative to tight blading

Pre-overlay Treatments for Bituminous and Concrete Overlays

- Grids/Fabrics
  - Acts as localized reinforcement over cracks
    - May delay reflective cracking
    - May reduce the number and severity of reflective cracks



Pre-overlay Treatments for Bituminous and Concrete Overlays

- Stress Absorbing Membrane Interlayer (SAMI)
  - – Majority of the existing pavement’s structural strength is utilized
  - – Bond between existing pavement and the overlay is broken to minimize reflective cracking

Pre-overlay Treatments for Bituminous and Concrete Overlays

Pre-overlay Treatment of Existing Pavements (NCHRP Project 20-5, Synthesis Topic 38-06)

- Synthesis of pre-overlay treatment selection
  - Decision process for determining pre-overlay treatment
  - Practices
  - Differences in practices associated with climate and material diversity

Recycling
FHWA - 2002 Recycled Materials Policy

- Recycled materials should get first consideration in materials selection
  - Recycling ⇒ engineering, economic & environmental benefits
  - Review engineering & environmental suitability
  - Assess economic benefits
  - Remove restrictions prohibiting use of recycled materials without technical basis

U.S. Department of Transportation
Federal Highway Administration

Recycling
Why Recycle?

- Improve serviceability of aged, deteriorated pavements
- Reduce raw material costs
- Level deformations & re-establish crowns
- Retain overhead clearances
- Minimize lane closure time, user delays
- Public acceptance of recycling
- Recycled pavement can be recycled itself

Recycling
When to Recycle?

- Pavement at end of its serviceable life
  - Fatigue (alligator) cracking
- Oxidized
- Raveling of thermal cracks - potholes
- Low clearances under bridges

Recycling Options
Bituminous

- Mill, haul and recycle at HMA plant
- Cold In-place Recycle (CIR)
  - Conventional
  - Engineered
- Hot In-place Recycle (HIR)
- Full Depth Reclamation (FDR)
  - Pulverization
  - Stabilization

Recycling Options Concrete

- Crack and Seat/Break and Seat
- Rubblization
- Break it up, remove, haul and process on site or at another facility
  - Product typically used for base
- Quality Control/Process Control limits options for recycling concrete

In-place Recycling
Bituminous Recycling Options

Cold In-Place Recycling

Full Depth Reclamation

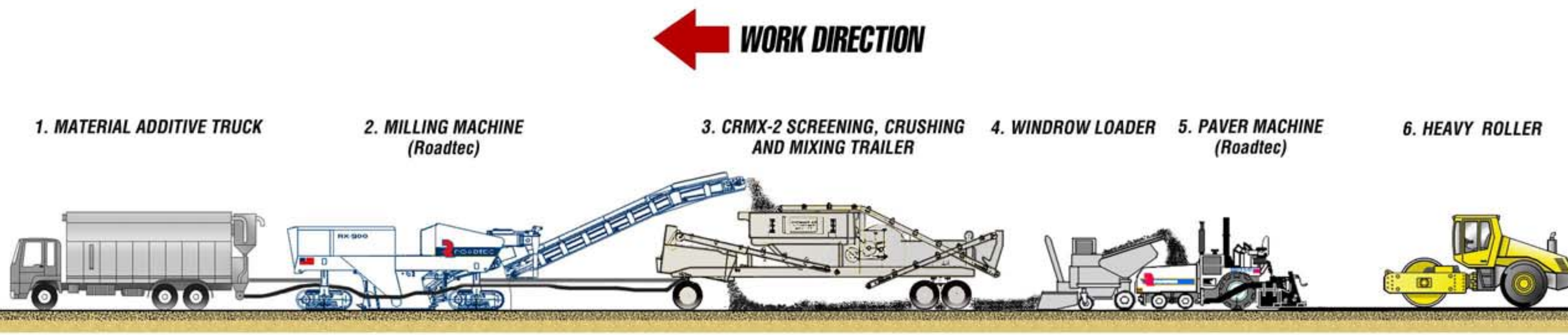
Cold In-place Recycling (CIR)

Cold In-place Recycling (CIR)

What is Cold In-place Recycling?

- CIR is the on-site rehabilitation of asphalt pavements without the application of heat during recycling.
- CIR interrupts the existing crack pattern and produces a crack-free layer for the new wearing course.

Cold In-place Recycling (CIR)
The Train Machine Concept



Pavement In-Place Recycling from Roadtec

Used when the Engineer’s design requires milled material needs to be screened, be of a uniform size and fully mixed in a pugmill

Cold In-place Recycling (CIR)

Illustration of CIR Process

Cold In-place Recycling (CIR)
Fundamentals of CIR

- Analyze existing structure & conditions
  - Understand causes for distress
- Correct any drainage or base problems
- Two options:
  - Conventional
  - Engineered design process

Comparison of Conventional and Engineered CIR

- Conventional
  - No mix design
    - 2% Emulsion
  - QC requirements
    - Two gradations per day
    - 100% passing 1-1/2”
    - 90-100% passing 1”
    - Control strip
- Engineered
  - Defined sampling protocol
  - Engineered design
  - Performance-related specs
  - Early strength & long term durability

Cold In-place Recycling (CIR)
Engineered CIR

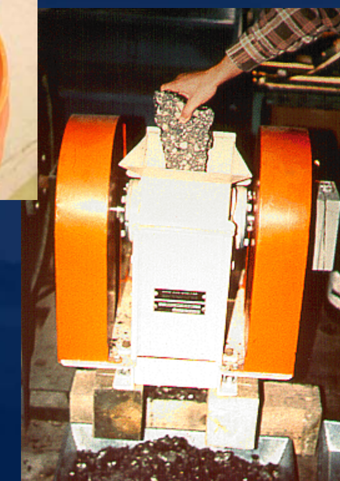
Less Raveling – Lab & Field

Raveling in the field

Samples & field photos from CSAH No. 20, Blue Earth County, MN

Cold In-place Recycling (CIR)
Fundamentals of CIR

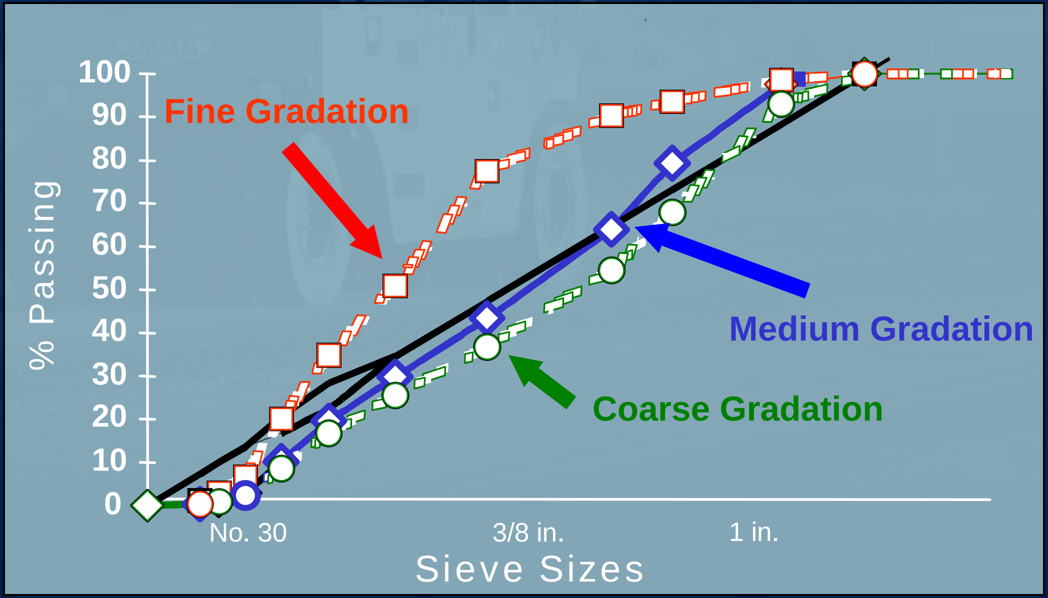
- Mix design
  - Reclaimed Asphalt Pavement (RAP) crushed to defined gradations
  - Emulsion formulated
  - Superpave Gyratory Compactor (SGC) mixes at field moisture content
- Performance-related tests



Cold In-place Recycling (CIR)
Mix Design

RAP/Base Analysis

- Foamed Asphalt, Engineered Emulsion and Fly Ash
  - Field cores crushed to 3 gradation bands
  - A design made for at least 2 gradations

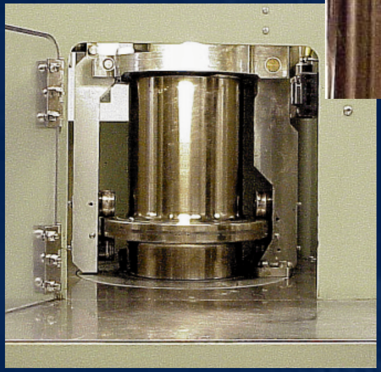


Cold In-place Recycling (CIR)

Mix Design

Superpave Gyratory Compactor

Lab



Field

Cold In-place Recycling (CIR)
Components of an Engineered CIR Project

- Site selection guidelines
- Mix design & performance testing
- Contractor & DOT training
- Job site support

Cold In-place Recycling (CIR)
Environmental Benefits of CIR

- No heat is used during the process thereby reducing the use of fossil fuels and also reducing air pollution.
- Since the existing aggregate and asphalt cement is reused, the need for virgin aggregate and asphalt cement are reduced or eliminated.
- 40% to 50% energy savings can be achieved using this process versus conventional approaches.

Cold In-place Recycling (CIR)
Applications for CIR

- Good candidates include pavement with:
  - At least 4” of hot mix
  - Adequate base and subgrade
  - Severe bituminous distresses
- Poor candidates include pavements with:
  - Inadequate base or subgrade support
  - Inadequate drainage
  - Paving fabrics or inter-layers

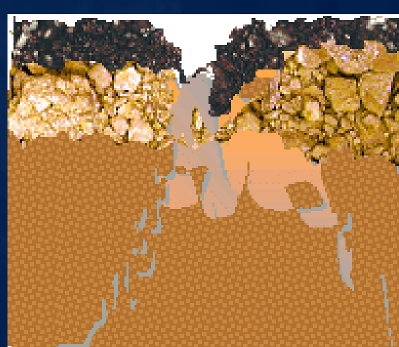
Full Depth Reclamation (FDR)

Full Depth Reclamation (FDR)
What is FDR?

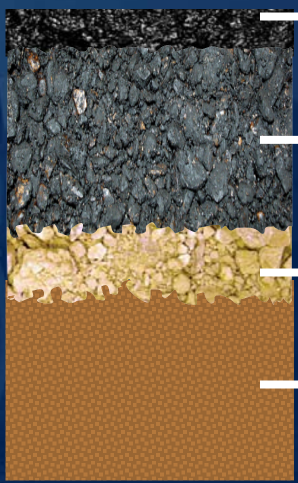
- The full thickness of the asphalt pavement and a predetermined portion of the base, subbase and/or subgrade is uniformly pulverized and blended to provide a homogeneous material.
- If new material is not a sufficient base for a new surface course, the reclaimed materials are stabilized by mechanical, chemical or bituminous means.

Full Depth Reclamation (FDR)
What is FDR?

Bituminous pavement needing repair



FDR Example



Overlay

6-10 inches stabilized material

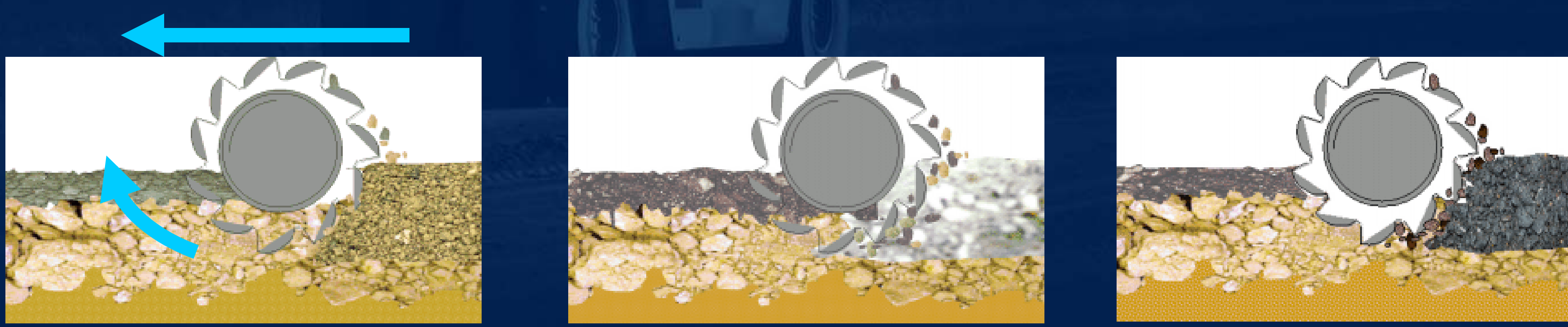
Granular base

Soil

Full Depth Reclamation (FDR)

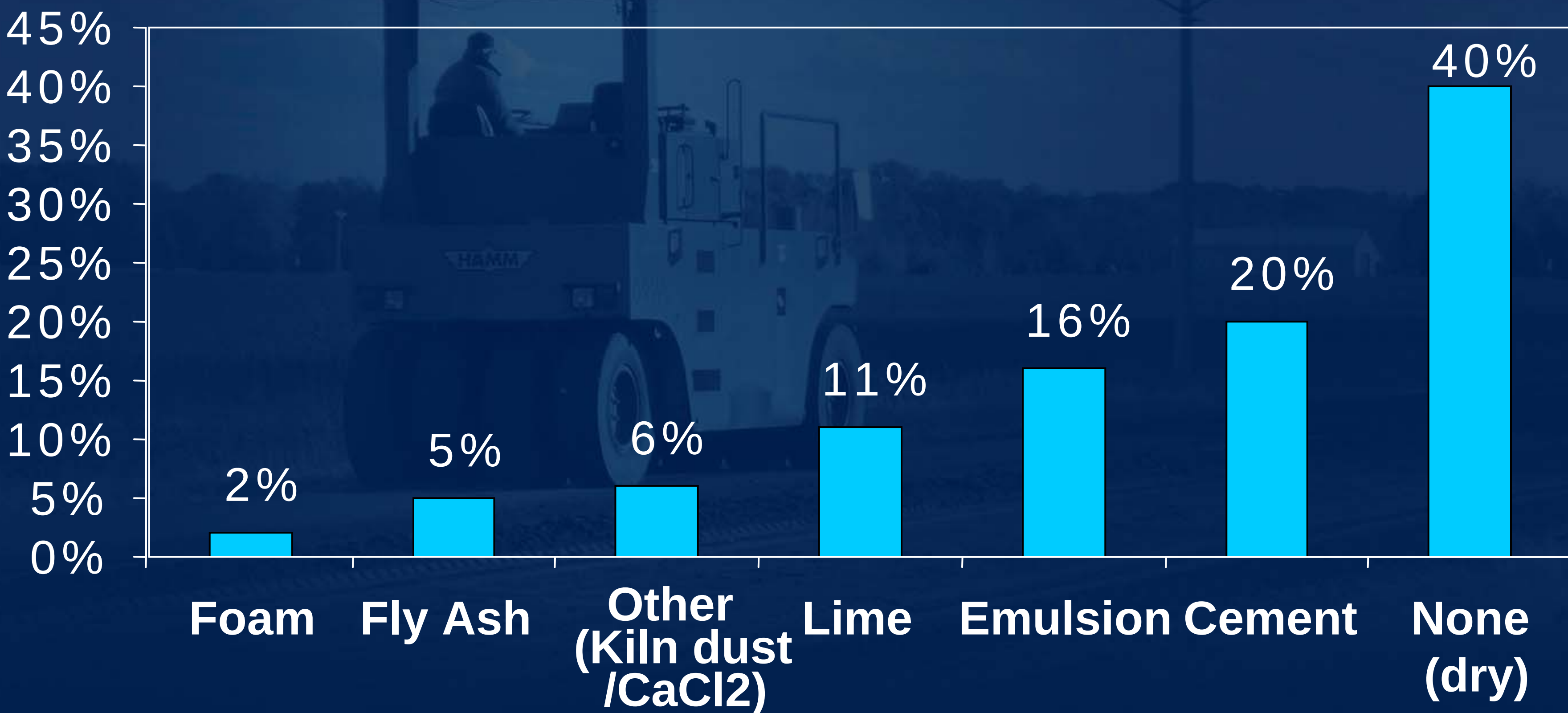
Types of FDR

- **Mechanical stabilization -** FDR without addition of binder (Pulverization)
- **Chemical stabilization -** FDR with chemical additive (Calcium or Magnesium Chloride, Lime, Fly Ash, Kiln Dust, Portland Cement, etc.)
- **Bituminous stabilization -** FDR with asphalt emulsion, emulsified recycling agent, or foamed/expanded asphalt additive



Full Depth Reclamation (FDR)
Types of FDR

Additives Used in Recycling



Full Depth Reclamation (FDR)
The Construction Process

1. Pulverize, blade & lightly compact before reclamation
   - Aids in material sizing if additive is added later
   - Corrects road profile, if needed
   - May not be necessary with very powerful reclaimers
2. Adjust moisture, reclaim/stabilize & mix additive (if applicable) with 6-10 inches of in-place with reclaimer or recycling train
   - Bituminous & granular material <u>or</u> granular material

Full Depth Reclamation (FDR)
The Construction Process

3. Compact
   - Padfoot roller
   - Blade to desired profile & remove pad marks
   - Final compaction - pneumatic and/or steel rollers
4. Cover with appropriate wearing surface after curing

Full Depth Reclamation (FDR)
Keys to Success

- Pavement & material assessment
- Engineered mix design
  - Choose correct additive for the application
- Performance-related specifications
- Construction guidelines & QC specs

Full Depth Reclamation (FDR)
Keys to Success

Pavement and Material Assessment

- Springtime (preferred) structural evaluation by agency or consulting engineer
  - Structure; layer evaluations
  - Drainage
  - Distresses
  - Road needs

Dynamic Cone Penetrometer (DCP)

Full Depth Reclamation (FDR)
Keys to Success

Pavement and Material Assessment

- Soil borings
  - Sample top 6-10 inches
  - Auger to 5 ft for:
    - layer thickness and identification
    - water table location

Full Depth Reclamation (FDR)
Keys to Success

Pavement and Material Assessment

- Strength testing options to identify weak areas and determine subgrade strength/modulus:
  - Falling Weight Deflectometer (FWD)
  - California Bearing Ratio (CBR) or R-Value
  - Dynamic Cone Penetrometer (DCP)
  - Proof rolling (granular surfaces only)

Full Depth Reclamation (FDR)
Keys to Success

Pavement and Material Assessment

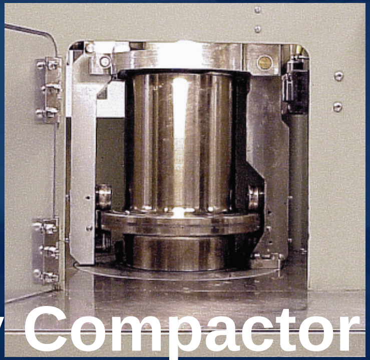
Falling Weight Deflectometer - FWD

CBR device

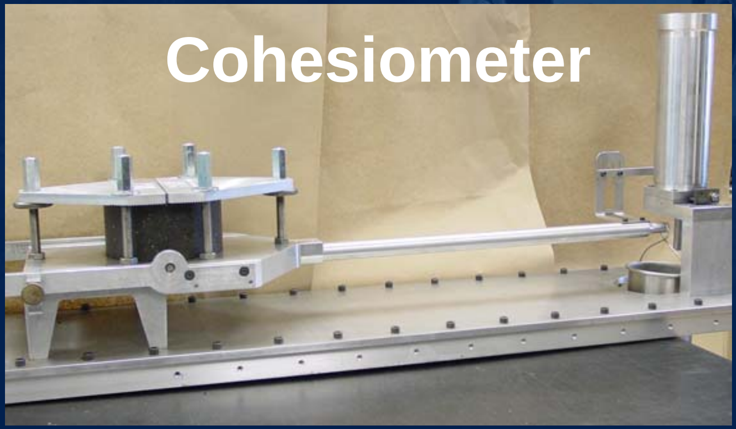
R-Value Determination (Hveem)

Full Depth Reclamation (FDR)
Keys to Success

Engineered Mix Design



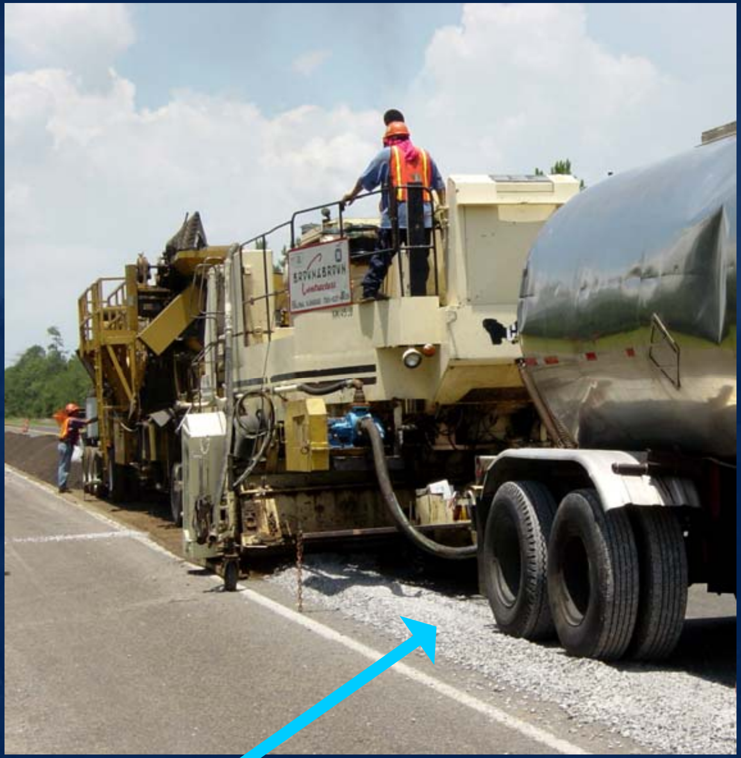
Superpave Gyratory Compactor



Full Depth Reclamation (FDR)
Keys to Success

Engineered Mix Design

- Virgin aggregate or RAP may be needed
  - To increase depth of finished structural layer
  - To improve gradation
    - Cleanliness (P200)
    - Material quality
    - Grading

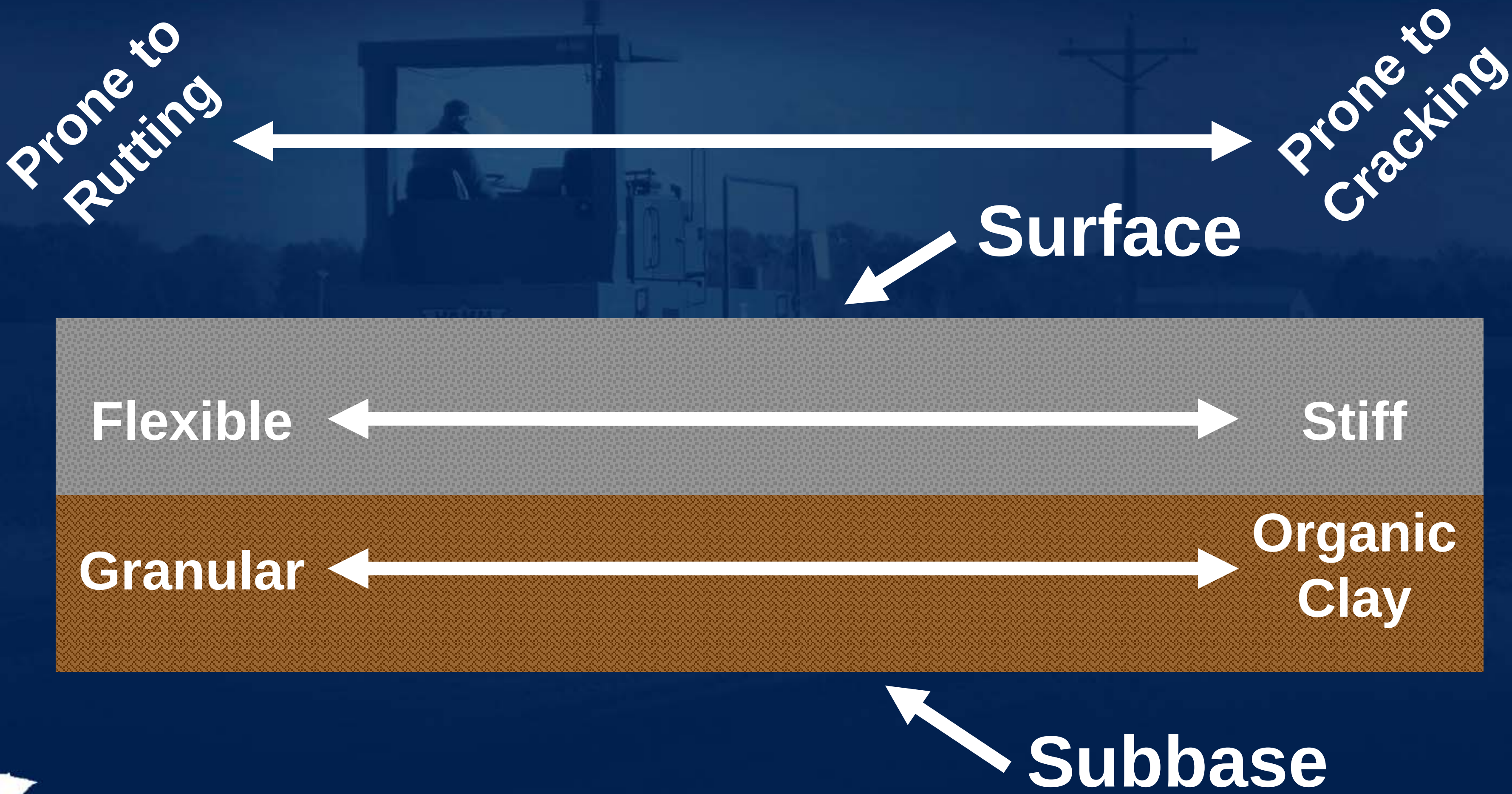


Add rock

Full Depth Reclamation (FDR)

Keys to Success

Stabilization Considerations



Full Depth Reclamation (FDR)
Keys to Success

Stabilization Considerations

Cutbacks or Road Mix

Proprietary Products

Engineered Emulsion

Foam Asphalt or Lime

Fly Ash or Cement

Prone to Rutting ⟷ **Prone to Cracking**

Flexible ⟷ **Stiff**

Granular ⟷ **Organic Clay**

Full Depth Reclamation (FDR)
Keys to Success

Stabilization Considerations

- Pulverization
  - Mill to 3”minus material
  - No stabilization required
  - Shape, compact
  - Granular Equivalent of 1 inch per inch

Full Depth Reclamation (FDR)
Keys to Success

Stabilization Considerations

- Engineered Emulsion Technology is formulated for:
  – High asphalt content
    - Good dispersion with higher film thickness
    - Durable
    - Flexible
  – Climate-specific binder
  – Formulated for each project

Full Depth Reclamation (FDR)
Keys to Success

Stabilization Considerations

- Fly Ash or Cement Stabilization
  - Mill to 3”minus material
  - Can incorporate some plastic subgrade soils
  - Cement addition rate of 2-4% by weight, fly ash addition rate of 6-10% by weight
    - Short working time due to hydration
  - Specific design for each project
  - Higher stiffness, lower flexibility

Full Depth Reclamation (FDR)
Keys to Success

Performance-Related Specification Guidelines

Criteria		Performance Parameter
Short Term Strength by **Cohesiometer**	**ASTM D1560**	Determine if appropriate early curing is occurring
Retained Strength	**ASTM D4867**	Resistance to moisture damage
Resilient Modulus	**ASTM D4123**	Relative indicator of quality
Indirect Tensile Test (IDT)	**AASHTO T 322**	Thermal cracking resistance
Construction & QA/QC Requirements		Reliability

Tests run on 150-mm SGC prepared specimens

Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control

- Equipment
  - Reclaimer
  - Padfoot compactor
  - Motor grader
  - Water truck
  - Finishing Rollers

Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control - Reclaimer

- Typically used in FDR construction
- Typical properties:
  - Center mount cutter
  - 8 or 10 feet wide
  - Accurate emulsion addition
  - Emulsion added to enclosed mixing drum
  - Cement or fly ash added after first pass of reclaimer
  - Road is usually reclaimed a third at a time

Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control - Padfoot Compactor

- Best for achieving compaction at bottom of layer
- High amplitude/ low frequency
- Back drag blade preferred
- Examples:
  - CAT CP 563C or 563D (rounded pads)
  - Hamm and Hypac
  - SuperPac (34,000 lb)
  - Hyster (28,000 lb)

Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control - Motor Grader

Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control - Water Truck

- Many varieties / homemade
- Ability to apply a uniform spray over the width of road
- Adjust initial moisture content, if needed
- Aids in final compaction and appearance

Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control - Finishing Rollers

- Achieve surface compaction & final appearance
- Pneumatic roller
  - 20 ton minimum
  - 90 psi tire pressure
- Vibratory steel roller
  - 10 ton minimum
  - low amplitude/ high frequency

Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control

- Field Testing
  - Specific tests & testing frequency determined by agency & road requirements
    - Water content
    - Depth
    - Top size
    - Additive content
    - Compaction
    - Modified Proctor for target density
    - Traffic return

Full Depth Reclamation (FDR)
Keys to Success

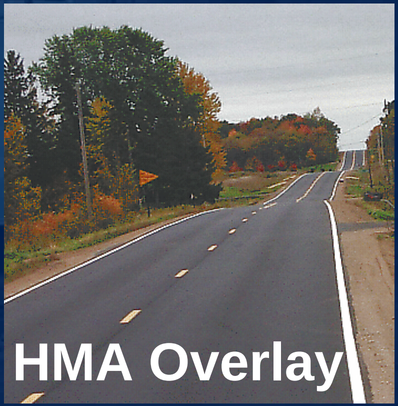
Construction and Quality Control

- Corrective actions
  - Sub-cut & replace weak spots
  - Fix drainage
  - Fix thickness deficiency
    - Add rock
  - Widen
    - Cut out soil

Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control

- Surfacing
  - To support needs of road
  - Structural
    - Traffic
    - Load levels
  - Climate
  - Chip seal at a minimum



Full Depth Reclamation (FDR)

FDR Expectations

- Site Assessment Critical
  - Can’t fix poor subgrades
  - If pre-construction assessment not done (borings, FWD, etc.), problems should be addressed during construction
- Amount of fines must be manageable
  - If surface or gravel base too thin, may have too many fines unless sufficient additional rock can be added

Full Depth Reclamation (FDR)
FDR Expectations

- Construction start-up expectation
  - Additives shouldn’t be added until moisture content is corrected, most notably
    - On all-gravel roads
    - In heavy rainfall or high water table areas
- Account for variability in road
  - Sufficient sampling & testing
  - Adjust as necessary during construction

Full Depth Reclamation (FDR)
FDR Expectations

- May require multiple reclaimer passes
  - For adequate sizing
  - For emulsion dispersion (high fines)
  - For moisture management
- Manage time to compaction when using additives
  - Too soon, soft areas
  - Too late, raveling

Full Depth Reclamation (FDR)
FDR Expectations

- Traffic control
  - Road may need to be closed during working day
    - Requires working full width of road
  - During construction, local traffic may need access to road if the full road width is being processed
  - During construction, constructing one lane at a time will require a pilot vehicle or an extra lane

Full Depth Reclamation (FDR)
Applications for FDR

- Good Candidates include pavements with:
  - Need for upgrading, widening or rehabilitation
  - Bituminous surface on compacted base that:
    - Has sufficient depth to accommodate reclamation process
    - Generally has up to 20% fines (P200)
  - High severity distresses
    - Cracks, Ruts, Edge Failures, Potholes
    - Base problems
  - Good drainage or drainage to be corrected

Full Depth Reclamation (FDR)
Applications for FDR

- Poor Candidates include pavements with:
  - Clay-like native soils
    - Exception- can be stabilized with fly ash
  - Doesn’t meet P200 criteria & can’t or won’t accept added rock
  - Drainage problems
    - Including ditch & regional flooding problems

Full Depth Reclamation (FDR)
Summary

- Builds structure down into pavement
  - Site assessment, sampling & mix design key to success
  - Performance-related design tests & specs improve reliability & performance
    - Early Strength
    - Cured Strength
    - Cracking Resistance
    - Moisture Resistance
    - QA / QC

CIR and FDR Differences

CIR and FDR Considerations:

- What is the depth of my existing pavement?
  - CIR is best for pavements at least 5” thick
  - FDR is for any depth
- Is the pavement thickness consistent or variable?
  - FDR is better for variable thickness pavements

CIR and FDR Differences

CIR and FDR Considerations (Continued):

- What is the condition and strength of the pavement base and subbase?
  - CIR requires base support for the heavy train equipment
  - FDR will break up cracking patterns in the base
- What is the required ease of construction?
  - CIR is all done at once
  - FDR has greater difficulty in getting material placed

CIR and FDR Differences

For CIR processes a mobile screen deck and pugmill are used to process aggregate and incorporate emulsions, foamed asphalt and/or other liquids or solids.

Pavement Reconstruction

What is Pavement Rehabilitation verses Reconstruction?

Applications for Pavement Reconstruction

- Reconstruction may be necessary in certain situations when there is/are:
  - No redeemable pavement life
  - Major subgrade corrections
  - Changes to roadway geometrics
  - Planning and development decisions
  - Utility construction

Concrete Pavement Rehabilitation Techniques

- Diamond Grinding
- Dowel Bar Retrofit
- Concrete or Bituminous Overlay
  - Unbonded Concrete Overlay
  - Bituminous Overlay
- Fracture and Overlay
  - Crack and Seat
  - Break and Seat
  - Rubblize
- Pavement Reconstruction

Diamond Grinding

Diamond Grinding
What is Diamond Grinding?

- Diamond Grinding corrects irregularities such as faulting and roughness.
- Other advantages of Diamond Grinding include:
  - Smooth riding surface
  - Noise reduction
  - Improved friction

Diamond Grinding
Fundamentals of Diamond Grinding

- All concrete repairs must be made before diamond grinding occurs.
- Existing joint seals may be removed prior to or in conjunction with the diamond grinding operation.

Diamond Grinding
Equipment and Materials for Diamond Grinding

- Equipment needed:
  - Diamond saw blades gang mounted on cutting head
  - Storage tanks for slurry
- Materials needed:
  - Water

Diamond Grinding
Design and Construction Considerations

- Traffic Control
- Noise
- Working hours
- Capturing slurry
- Cost

Diamond Grinding
Applications for Diamond Grinding

- Good Candidates include pavements with:
  - Minor surface deficiencies, but are structurally sound
  - Major CPR (Concrete Pavement Rehabilitation)
- Poor Candidates include pavements with:
  - Structural deficiencies
  - Severe drainage or erosion problems
  - Progressive transverse slab cracking and corner breaks at joints

Dowel Bar Retrofit

Dowel Bar Retrofit
What is Dowel Bar Retrofit?

- Dowel Bar Retrofit is a rehabilitation technique for increasing the load transfer capability of existing jointed Portland Cement Concrete (PCC) pavement by placement of dowel bars across joints and/or cracks that exhibit poor load transfer.

Dowel Bar Retrofit
Fundamentals of Dowel Bar Retrofit

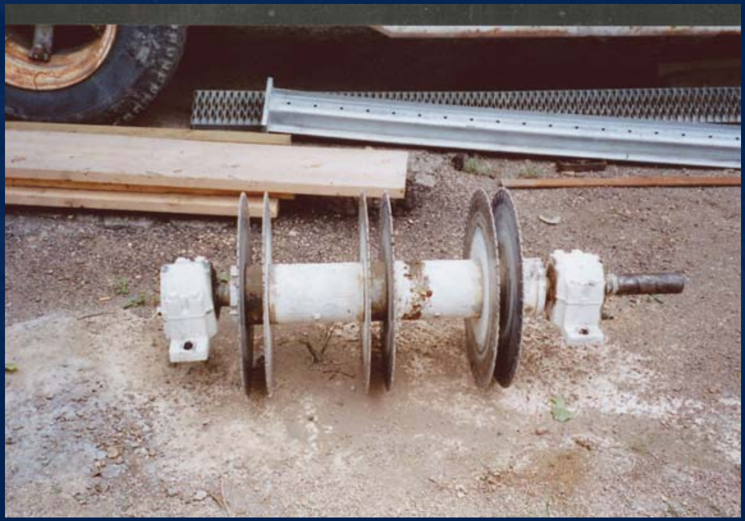
- Cut slots across joint at the wheel path
  - Typically 3 slots
- Insert dowel bars into slots

Dowel Bar Retrofit
Fundamentals of Dowel Bar Retrofit

- Fill slot with grout
  - Small maximum aggregate size is used to ensure grout fills in completely around the dowel
- Diamond grind the entire pavement area

Dowel Bar Retrofit
Equipment for Dowel Bar Retrofit

- Equipment needed:
  - To cut slots for dowel bars use either:
    - Diamond saw slot cutter
    - Modified milling machine
  - Small jack hammer
  - Small spud vibrator



Dowel Bar Retrofit
Materials for Dowel Bar Retrofit

- Materials needed:
  - Epoxy coated dowels with expansion caps and chairs
  - Concrete form oil as a bond breaker
  - Joint forming insert
  - Caulking
  - Backfill material

Dowel Bar Retrofit
Design and Construction Considerations

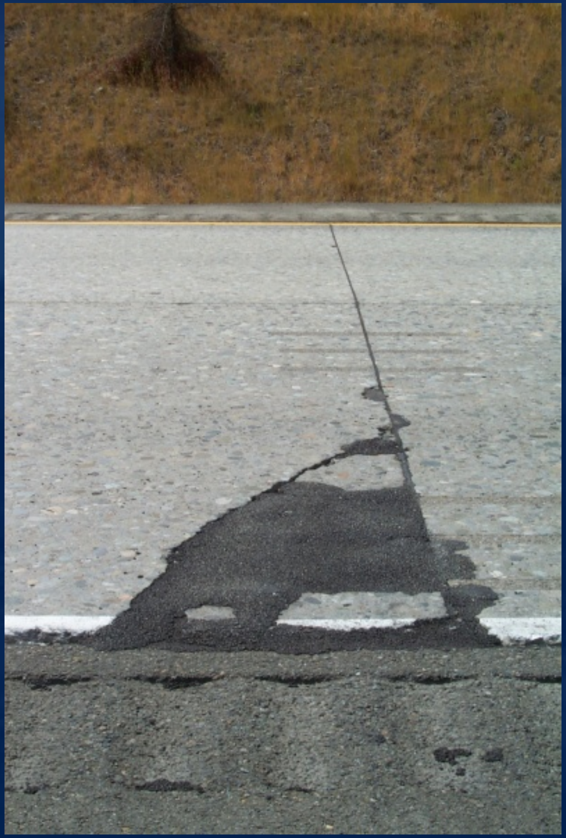
- Indicators that an individual joint or crack would benefit from dowel bar retrofit include:
  - Deflection load transfer of 60 percent or less.
  - Faulting greater than ¼ inch.
  - Differential deflection of 0.0098 inches or more.

Dowel Bar Retrofit
Applications for Dowel Bar Retrofit

- Good candidates include pavements with:
  - Significant remaining structural life, but significant loss of load transfer due to:
    - Poor aggregate interlock - undoweled
    - Erosion of base support at the joint
    - Excessive joint spacing
      - Mid-panel cracking

Dowel Bar Retrofit
Applications for Dowel Bar Retrofit

- Poor candidates include pavements with:
  - Little remaining structural life
  - A substantial amount of slab cracking
  - Faulted doweled joints



Concrete over Concrete Overlays

Concrete over Concrete Overlays
What is an Unbonded Concrete Overlay?

- A concrete resurfacing is placed on an existing concrete pavement with a separator layer between to ensure there is no bond created between the two concrete pavements.

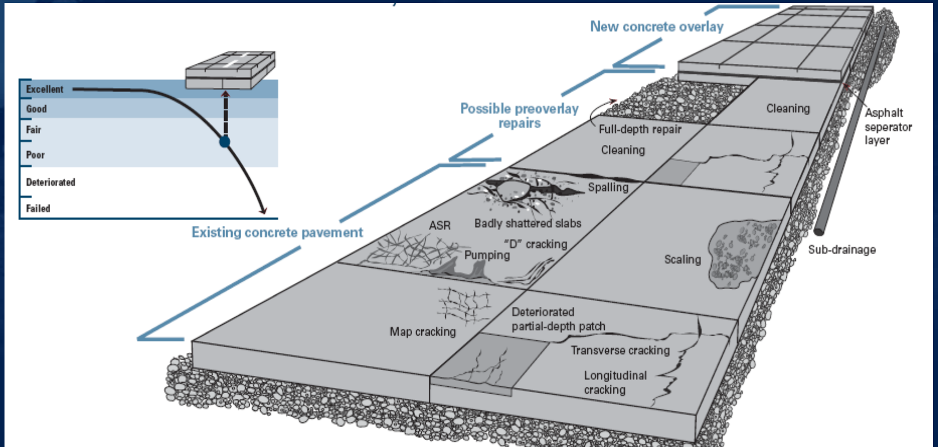


Fig. 1. Concrete overlay of poor condition concrete pavement

Concrete over Concrete Overlays
Fundamentals of Unbonded Concrete Overlays

1. Pavement Evaluation
2. Resurfacing Design
   - Separator Layer
   - Resurfacing Thickness
     - Typically 6 – 11 inches on high volume roads
     - Minimum of 4 inches on low volume roads
   - Mixture Design
   - Joint Design
   - Drainage Design
   - Edge Support Design

Concrete over Concrete Overlays

Fundamentals of Unbonded Concrete Overlays

Unbonded resurfacing thickness	Maximum transverse joint spacing
< 5 in. (12.7 cm)	6 x 6 ft (1.8 x 1.8 m) panels
5–7 in. (12.7–17.8 cm)	Spacing in feet = 2 times thickness in inches
> 7 in. (17.8 cm)	15 ft (4.6 m)

Source: Guide to Concrete Overlay Solutions

Concrete over Concrete Overlays
Fundamentals of Unbonded Concrete Overlays

3. Pre-resurfacing Work
   - Pre-surface Repairs
   - Separator Layer

Concrete over Concrete Overlays
Fundamentals of Unbonded Concrete Overlays

Existing pavement condition	Possible repairs to consider
Faulting ¼–⅜ in. (6.4–9.5 mm)	None
Faulting > ⅜ in. (9.5 mm)	Thicker separator layer
Significant tenting	Full-depth repair
Badly shattered slabs	Full-depth repair
Significant pumping	Full-depth spot repair and drainage improvements
Severe joint spalling	Clean
CRCP with punchouts or other severe damage	Full-depth repair

Source: Guide to Concrete Overlay Solutions


Concrete over Concrete Overlays

Fundamentals of Unbonded Concrete Overlays

4. Construction
   - Concrete Placement
   - Curing
   - Joint Sawing

Concrete over Concrete Overlays
Equipment and Materials for Unbonded Concrete Overlays

- Equipment needed:
  - Conventional asphalt and concrete paving equipment
- Materials needed:
  - Conventional concrete materials
  - Conventional or open-graded asphalt materials
  - Concrete anchorages to secure dowel baskets

Concrete over Concrete Overlays
Design and Construction Considerations

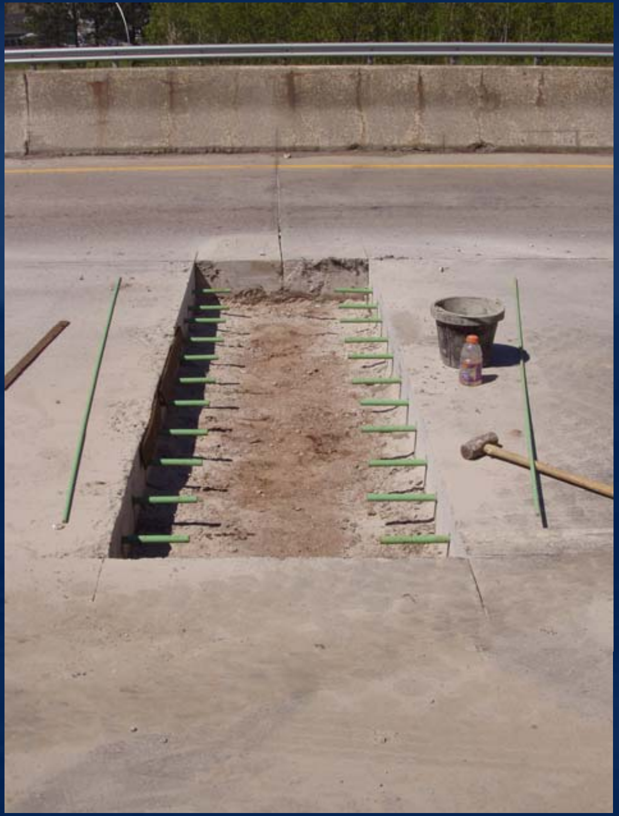
- Vertical clearance
- Number of culverts and bridges
- Drainage
- Materials
- Schedule
- Traffic

Concrete over Concrete Overlays
Applications for
Unbonded Concrete Overlays

- Good Candidates include pavements that:
  - Are in poor condition
- Poor Candidates include pavements that:
  - Need significant widening or realignment
  - Have significant frost heaving problems

Bituminous over Concrete Overlays
What is a Bituminous over Concrete (BOC) Overlay?

- Basics are the same as described for the BOB earlier
- Pre-overlay preparation:
  - Patch potholes with concrete or asphalt
    - Large areas should be patched with concrete for uniform support
  - Apply tack coat prior to overlay
  - Leveling course to correct for faulted surface



Bituminous over Concrete Overlays
Equipment and Materials for BOC Overlays

- Equipment needed:
  - Conventional asphalt paving equipment
- Materials needed:
  - Conventional asphalt materials

Bituminous over Concrete Overlays
Design and Construction Considerations

- Joint spacing in the concrete pavement
  - Determines material selection for overlay
- Extent of pre-overlay repair
- Construction traffic
- Design traffic

Bituminous over Concrete Overlays
Applications for BOC Overlays

- Good Candidates include pavements with:
  - Significant surface distresses, but are structurally sound
  - A life cycle cost that indicates a bituminous overlay is the most cost effective
  - Schedule considerations
- Poor Candidates include pavements with:
  - Structural deficiencies
    - Rubblize and overlay or crack and seat

Fracture-and-Overlay

Fracture-and-Overlay

What is Fracture-and-Overlay?

- Pavement is fractured to the specified size in order to minimize reflection cracking.
- Seating of the fractured pavement is intended to re-establish support between the base or subbase and the fractured slab.
- A bituminous overlay accommodates the thermal and traffic stresses.
- A concrete overlay accommodates the traffic stresses and a bond breaker accommodates the thermal stresses.

Fracture-and-Overlay
Fracture-and-Overlay Types

- Crack and Seat (non-reinforced concrete)
  - The maximum recommended crack spacing is 12-30 inches.
- Break and Seat (reinforced concrete)
  - The recommended fragment size is between 6 and 24 inches, with 12 to 18 inches preferred.
- Rubblize
  - The recommended fragment size is between 4 and 8 inches or less.

Fracture-and-Overlay
Equipment for
Crack and Seat / Break and Seat

- Equipment needed:
  - To crack/break the pavement use one of the following:
    - Guillotine
    - Hydraulic/Pneumatic Hammers
  - To seat the pavement use:
    - Two to three passes with a 35-50 ton rubber tire roller

Fracture-and-Overlay
Equipment and Materials for Overlaying Fracture-and-Seat

- To overlay use:
  - Conventional asphalt or concrete paving equipment
- Materials needed:
  - Conventional asphalt or concrete materials
  - Asphalt interlayer if using concrete overlay

Fracture-and-Overlay
Applications for Crack and Seat

- Good Candidates include:
  - Faulted non-reinforced concrete pavement
  - Pavement with any level of surface distress
- Poor Candidates include:
  - Reinforced concrete pavement
  - Continuously Reinforced Concrete Pavement (CRCP)

Fracture-and-Overlay
Applications for Break and Seat

- Good Candidates include:
  - Jointed Reinforced Concrete Pavement (JRCP)
- Poor Candidates include:
  - Continuously Reinforced Concrete Pavement (CRCP)

Fracture-and-Overlay
Equipment for Rubblization

- Equipment needed:
  - To shatter pavement use one of the following:
    - Resonant pavement breaker
    - Multiple head pavement breaker
  - To compact rubblized pavement use:
    - Several passes of a 10 ton vibratory roller

Fracture-and-Overlay
Equipment and Materials for Overlaying Rubblization

- To overlay use:
  - Tracked paver for the first lift of bituminous pavement
  - Any type of paver for the remaining lifts
- Materials needed:
  - Conventional asphalt materials

Fracture-and-Overlay
Fundamentals for Fracture and Overlays

- Remove any existing bituminous overlay.
- Remove any joint seal material.
- Use a test section to establish crack pattern.
- The smaller the crack spacing/particle size, the greater the likelihood that reflection cracking will be eliminated in the bituminous overlay.

Fracture-and-Overlay
Applications for Rubblization

- Good Candidates include:
  - Reinforced concrete in any condition (the worse the better)
  - Non-reinforced concrete
- Poor Candidates include:
  - Concrete pavements in good condition
  - Concrete pavements on poor base or subgrades
  - Continuously Reinforced Concrete Pavement (CRCP)

Pavement Reconstruction

What is Pavement Rehabilitation verses Reconstruction?

Applications for Pavement Reconstruction

- Reconstruction may be necessary in certain situations when there is/are:
  - No redeemable pavement life
  - Major subgrade corrections
  - Changes to roadway geometrics
  - Planning and development decisions
  - Utility construction