Strengthening Base instead of Paving:

Regional Local Road Conference
Rapid City, South Dakota
October 21 & 22, 2009
OVERVIEW

- ROAD TYPES
  - BASE STRENGTHENING APPLIES TO ALL
- KEY CONSIDERATIONS for SUCCESS
  - PAVEMENT ASSESSMENT
- REHAB SELECTION
  - ASSURE PERFORMANCE
- QUESTIONS/COMMENTS
ROAD TYPES

- **GRAVEL**
  - What are my current costs?
  - What are my future needs?

- **RURAL HMA**
  - Staged construction/perpetual pavents

- **URBAN HMA**
  - Adding strength to existing design

- **INTERSTATE HMA – Mn/Road**
GRAVEL
(Unpaved)

Lincoln Highway between Ames and Nevada, 1918.
(Courtesy: Iowa State Highway Commission)
Traffic’s effect on maintenance costs/mile

- Roads grouped by traffic volumes and surface type
- An increase in traffic should lead to an increase in maintenance costs, particularly for gravel roads:
  - More gravel needed
  - More blading and smoothing of road surface needed

![Graph showing maintenance costs for different traffic volumes and surface types.](attachment://graph.png)
Cumulative maintenance costs/mile over time for a gravel road

- Rehabilitation Alternative
- Initial Construction
- Routine Maintenance (Re-Grading)
- Periodic Re-Graveling

Cumulative Total Cost ($)
RURAL HMA
(Limited Design)

- Limited Pavement and Mix Design
  - Pavement designs assume stronger base
  - Mix designs were economized
  - Performance suffers as expectations rise
- Staged Construction options
  - Rehab economics
- Perpetual Pavement Design Goal
  - Current research providing more tools
Interstate Expectations

Percent Change Since 1970

- Rural Average Daily Load
- Rural Average Daily Traffic

[Graph showing the percent change in rural average daily load and traffic from 1970 to 2005.]
Staged Construction options

Granular pavement needing upgrading

Bituminous pavement needing repair

GBS
Overlay
6-10 inch stabilized material
Granular base
Soil
FDR
Perpetual Pavement
Design Goal

- Proper roadway/pavement assessment
- Selection of best rehab option
- Selection of process and materials
- Best Practices Construction (manage risk)
- Lowest Life Cycle Cost (LLC)
- Optimized Performance (safety, ride, durability)
APA Perpetual Pav’t

Max Tensile Strain

Pavement Foundation

Flexible Fatigue Resistant Material 3" - 4"

High Modulus Rut Resistant Material (Varies As Needed)

Zone Of High Compression

4” to 6”
INTERSTATE HMA
Mn/Road – I 94

- Cell 2
  - 50% RAP
- Cell 3
  - 75% RAP
- Cell 4
  - 100% RAP
Mn/Road – I 94

MnROAD Facility

- Workshop and Storage Building
- Entrance
- Parking Lot
- Pervious Parking Lot Cell 64
- Pervious Sidewalk Cell 74
- Research Operations Center

Weather Station

Low Volume Road

Westbound I-94 (MnROAD Mainline)

Westbound I-94 (Bypass)

Stockpile Area

Farm Loop Cells 83 and 84

Weigh in Motion

MnROAD – Mainline

Westbound I-94

- Up-Up Transition
- 50, 51, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23
- 105, 106, 209, 206, 305, 405, 409

Westbound I-94 (Bypass)

Eastbound I-94
# Base Stabilization Cells 2,3,4

<table>
<thead>
<tr>
<th>CELL</th>
<th>RAP</th>
<th>Stab.</th>
<th>EE</th>
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<tbody>
<tr>
<td>2</td>
<td>50%</td>
<td>6 inch</td>
<td>4%</td>
</tr>
<tr>
<td>3</td>
<td>75%</td>
<td>6 inch</td>
<td>3%</td>
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<tr>
<td>4</td>
<td>100%</td>
<td>8 inch</td>
<td>.075%</td>
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<tr>
<td>SHLD</td>
<td>50%</td>
<td>4 inch</td>
<td>4.5%</td>
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</table>
Max Tensile Strain

2-3” Zone Of High Compression

High Modulus Rut Resistant Material

1.5 - 3” SMA, OGFC or Superpave

Flexible Fatigue Resistant Material 6 - 8”

Pavement Foundation
KEY CONSIDERATIONS

- What are short and long term plans for road?
- What Roadway History information is available?
- Do I know the root cause of pavement issues?
- What options fit my desired result?
- What additional information do I need to evaluate my options?
- Where can I go for help?
Where can I go for help?

Asphalt Recycling and Reclaiming Association
ARRA – www.arra.org

Pavement Interactive Website - www.pavementinteractive.org

National Asphalt Pavement Association
NAPA – www.hotmix.org

National Center for Pavement Preservation
NCPP - www.pavementpreservation.org

Transportation Engineering and Road Research Alliance
TERRA – www.terraroadalliance.org

Federal Highway Administration
FHWA – www.fhwa.dot.gov/pavement
# Rehabilitation Selection

**BARM**

<table>
<thead>
<tr>
<th>Pavement Distress Mode</th>
<th>Candidate Rehabilitation Techniques</th>
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<tbody>
<tr>
<td></td>
<td>CP</td>
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<td>Raveling</td>
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<td>Bleeding</td>
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<td>Skid Resistance</td>
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<td>Shoulder Drop Off</td>
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<td>Rutting</td>
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<td>Corrugations</td>
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<td>Shoving</td>
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<td>Fatigue Cracking</td>
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<td>Edge Cracking</td>
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<td>Slippage Cracking</td>
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<td>Block Cracking</td>
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<td>Longitudinal Cracking</td>
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<td>Transverse Cracking</td>
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<td>Reflection Cracking</td>
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<td>Discontinuity Cracking</td>
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<td>Swells</td>
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<td>Bumps</td>
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<td>Sags</td>
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<tr>
<td>Depressions</td>
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<tr>
<td>Ride Quality</td>
<td></td>
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<tr>
<td>Strength</td>
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- **Most Appropriate**
- **Least Appropriate**
Pavement Assessment

Keys to Success

Determine the Root Cause

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

Dynamic Cone Penetrometer (DCP)
Pavement and Material Assessment
Keys to Success

- 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)
Pavement Assessment
Pavement Condition/Distress Survey

Pavement Condition Data can be collected either Manually or with Automated equipment.
Pavement Assessment
Pavement Strength Evaluation

- Ground Penetrating Radar (GPR) Data
  - Provides a “picture” of pavement structure
  - Used for FWD Analysis
Pavement Assessment
Pavement Strength Evaluation

- Road Surface
- Binder Course Bottom
- Base Layer Bottom
- Metal strips buried at layer interfaces
- Base Layer Bottom
Pavement Assessment
Surface, Base and Subgrade Analysis

- **Coring**
  - Determination of pavement thickness, layering, condition of each layer, bonding between layers, presence of materials related to distress and strength

- **Soil Borings/GPR**
  - Thickness, type or classification, moisture content, contamination, strength determination
Pavement and Materials Assessment
Approximate Costs

- Coring - $1,000 to $1,500 (per project < 2 miles)
- Soil / pavement borings ~$1,000 (per mile)
- FWD w/ analysis - $2,000 to $5,000 (per project < 2 miles)
- Sampling & subgrade testing - $2,500 (per project < 2 miles)
- DCP - equipment costs $1,500 (per project < 2 miles)

Costs will vary depending on many factors, especially mobilization and traffic control.
REHAB SELECTION

- Review pavement history
  - Typical sections
  - Existing distress and root cause of the problem
- Identify Rehab Options
  - CIR
  - FDR
  - Material Considerations
- Select for Success (I have done my homework)
CIR (Train Method)

WORK DIRECTION

1. MATERIAL ADDITIVE TRUCK
2. MILLING MACHINE (Roadtec)
3. CRMX-2 SCREENING, CRUSHING AND MIXING TRAILER
4. WINDROW LOADER
5. PAVER MACHINE (Roadtec)
6. HEAVY ROLLER

Cutting Width Min. 2500 mm - Max. 3810 mm
Cutting Depth 0 - 335 mm

2.44 m to 6.0 width

Pavement In-Place Recycling from Roadtec
CIR (w/o Train)
Cold In-place Recycling (CIR) Fundamentals of 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) 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

![Graph showing gradation bands for Blue Earth County, MN](image)
Cold In-place Recycling (CIR)
Engineered CIR

Less Raveling – Lab & Field

Conventional CIR
25.7% mass loss

Engineered CIR
1.6% loss

Raveling in the field

Samples & field photos from CSAH No. 20, Blue Earth County, MN
Full Depth Reclamation (FDR)
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)  
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

Engineered Mix Design

Superpave Gyratory Compactor

Cohesiometer

Lab Mixer
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

- Cutbacks or Road Mix
- Proprietary Products
- Engineered Emulsion
- Foam Asphalt or Lime
- Fly Ash or Cement

Prone to Rutting
Flexible
Granular

Stiff
Organic Clay

Prone to Cracking
Full Depth Reclamation (FDR) Keys to Success

Stabilization Considerations

Prone to Rutting

Flexible

Granular

Subbase

Surface

Stiff

Organic Clay

Prone to Cracking
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)  
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

- Equipment
  - Reclaimer
  - Padfoot compactor
  - Motor grader
  - Water truck
  - Finishing Rollers
3 C’s to evaluate new technology

- Constructability
- Cost
- Credibility
Constructability

- About the same as HMA but you need to manage the weather
Cost

- About the same as HMA but you need to manage the market

  - Managing the market is much easier than the weather
Credibility

- Engineered Emulsion is a product I will always endorse but you need to manage the process.
  - Process is very easy to manage but you need to have credibility which only comes with success
Full Depth Reclamation (FDR)

Keys to Success

Stabilization Considerations

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Thank you.

Questions?