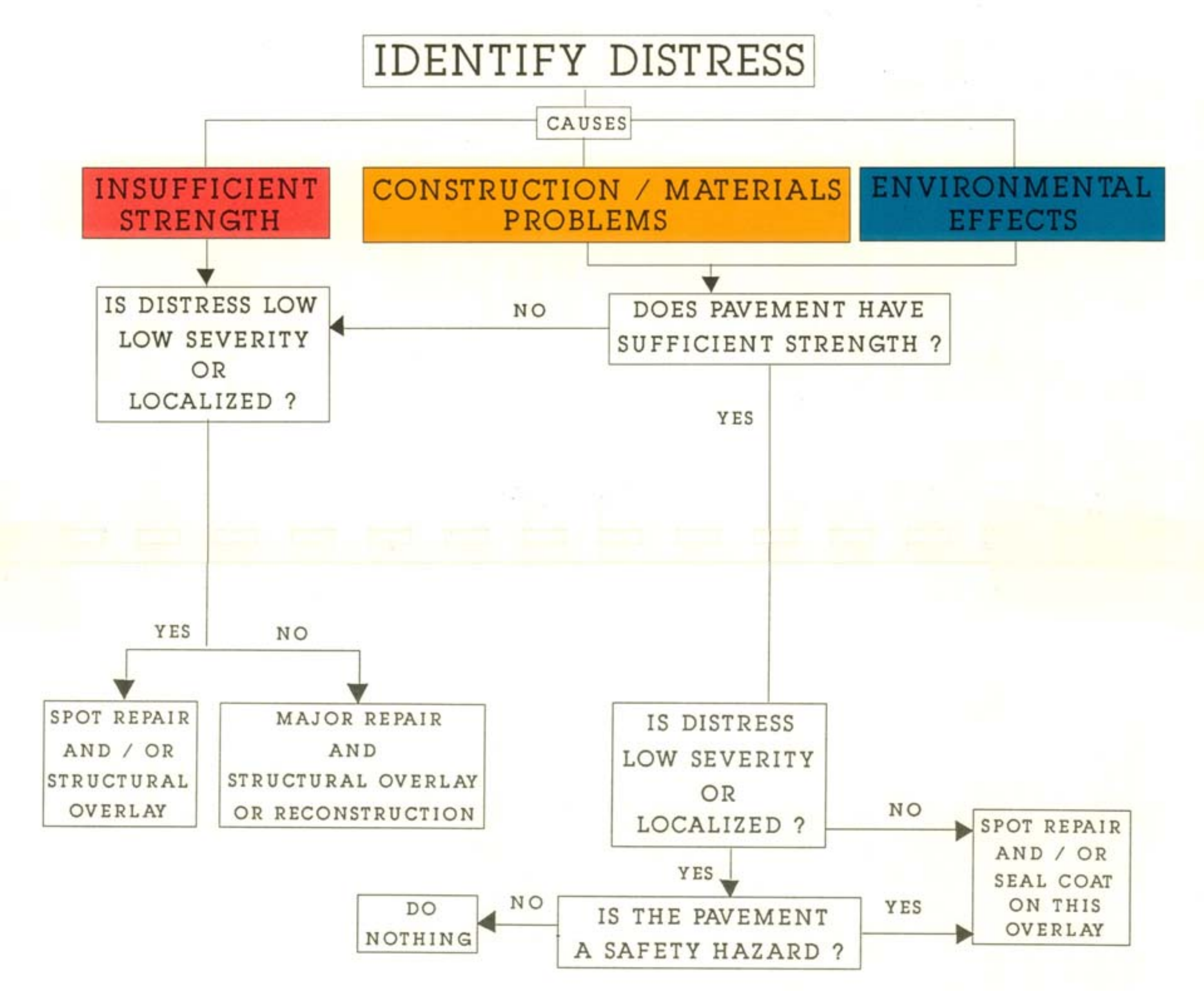
Pavement Rehabilitation Selection
Making a Decision:
Applying What You've Learned

Rehabilitation Selection

- Tools for Decision Making
  - Bituminous Pavement
    - LRRB - Flexible Pavement Distress Manual
    - LRRB - Investigation 808
    - Basic Asphalt Recycling Manual (BARM)
    - Industry Input

Rehabilitation Selection
Flexible Distress Manual



Rehabilitation Selection Flexible Distress Manual

LOW SEVERITY ALLIGATOR CRACKING

MEDIUM SEVERITY ALLIGATOR CRACKING

HIGH SEVERITY ALLIGATOR CRACKING

Name of Distress: ALLIGATOR CRACKING

Description: Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading. Alligator cracking occurs only in areas subjected to repeated traffic loading, such as wheelpaths. Therefore, it would not occur over the entire paved area unless the entire area were subjected to the traffic loading. (Pattern-type cracking, which occurs over an area that is not subjected to loading, is called block cracking. See "Block Cracking" in this report.)

Alligator cracking is usually considered a major structural distress. The degree of structural impact is dependent on the section. Alligator (fatigue) cracking, in its early stages, will show up as a low severity longitudinal crack in the wheelpath. This form of longitudinal cracking can, in most cases, be distinguished from cold joint cracks or cracking caused by the lateral movement of the subgrade (see longitudinal cracking).

Severity Levels:

Low severity: Fine, longitudinal hairline cracks running parallel to each other with none or only a few interconnecting cracks. The cracks are not spalled (See "Spalling" in this report). Initially there may be only a single crack in the wheelpath.

Medium severity: Further development of light alligator cracks into a pattern or network of cracks that may be lightly spalled.

High severity: Network or pattern cracking has progressed so that the pieces are well defined and spalled at the edges. Some of the pieces may rock under traffic. Pieces may begin to disintegrate forming potholes.

How to Measure: Alligator cracking is measured in square feet of surface area. The major difficulty in measuring this type of distress is that two or three levels of severity often exist within one distressed area. If the different levels of severity can be easily distinguished from each other, they should be measured and recorded separately. However, if they cannot be divided easily, the entire area should be rated at the highest severity level present.

Rehabilitation Alternatives:

If distress is localized:

Low severity: Apply surface seal coat. Rejuvenators may also be considered as an alternative. Minnesota's experience has been limited and there are no documented studies available relevant to their local use. A rejuvenator could be used if it will aid in healing the surface and reducing the amount of water that can enter the base. Expected life of the treatment will range from less than a year to 5 years, depending on the structure and the section traffic.

Medium severity: Partial depth patch; Full depth patch.

High severity: Partial depth patch; Full depth patch.

If distress is more wide spread:

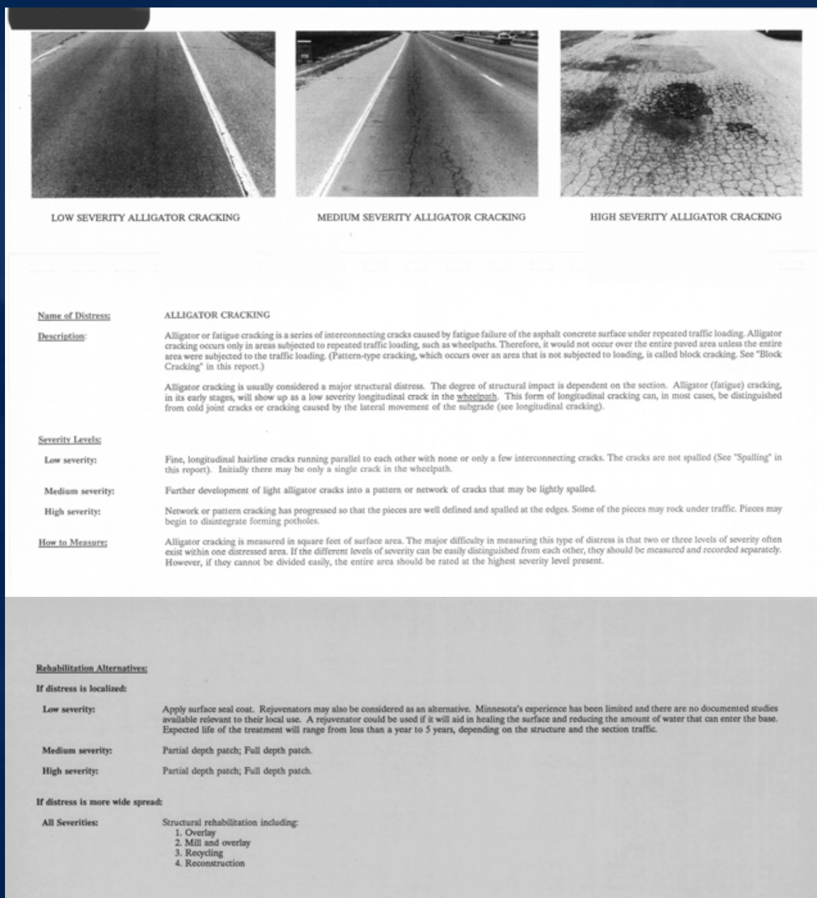
All Severities: Structural rehabilitation including:
1. Overlay
2. Mill and overlay
3. Recycling
4. Reconstruction

Description

Severity Level

How to Measure

Rehabilitation Selection Flexible Distress Manual



LOW SEVERITY ALLIGATOR CRACKING

MEDIUM SEVERITY ALLIGATOR CRACKING

HIGH SEVERITY ALLIGATOR CRACKING

Name of Distress: ALLIGATOR CRACKING

Description: Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading. Alligator cracking occurs only in areas subjected to repeated traffic loading, such as wheelpaths. Therefore, it would not occur over the entire paved area unless the entire area were subjected to the traffic loading. (Pattern-type cracking, which occurs over an area that is not subjected to loading, is called block cracking. See "Block Cracking" in this report.)

Alligator cracking is usually considered a major structural distress. The degree of structural impact is dependent on the section. Alligator (fatigue) cracking, in its early stages, will show up as a low severity longitudinal crack in the wheelpath. This form of longitudinal cracking can, in most cases, be distinguished from cold joint cracks or cracking caused by the lateral movement of the subgrade (see longitudinal cracking).

Severity Levels:

Low severity: Fine, longitudinal hairline cracks running parallel to each other with none or only a few interconnecting cracks. The cracks are not spalled (See "Spalling" in this report). Initially there may be only a single crack in the wheelpath.

Medium severity: Further development of light alligator cracks into a pattern or network of cracks that may be lightly spalled.

High severity: Network or pattern cracking has progressed so that the pieces are well defined and spalled at the edges. Some of the pieces may rock under traffic. Pieces may begin to disintegrate forming potholes.

How to Measure: Alligator cracking is measured in square feet of surface area. The major difficulty in measuring this type of distress is that two or three levels of severity often exist within one distressed area. If the different levels of severity can be easily distinguished from each other, they should be measured and recorded separately. However, if they cannot be divided easily, the entire area should be rated at the highest severity level present.

Rehabilitation Alternatives:

If distress is localized:

Low severity: Apply surface seal coat. Rejuvenators may also be considered as an alternative. Minnesota's experience has been limited and there are no documented studies available relevant to their local use. A rejuvenator could be used if it will aid in healing the surface and reducing the amount of water that can enter the base. Expected life of the treatment will range from less than a year to 5 years, depending on the structure and the section traffic.

Medium severity: Partial depth patch; Full depth patch.

High severity: Partial depth patch; Full depth patch.

If distress is more wide spread:

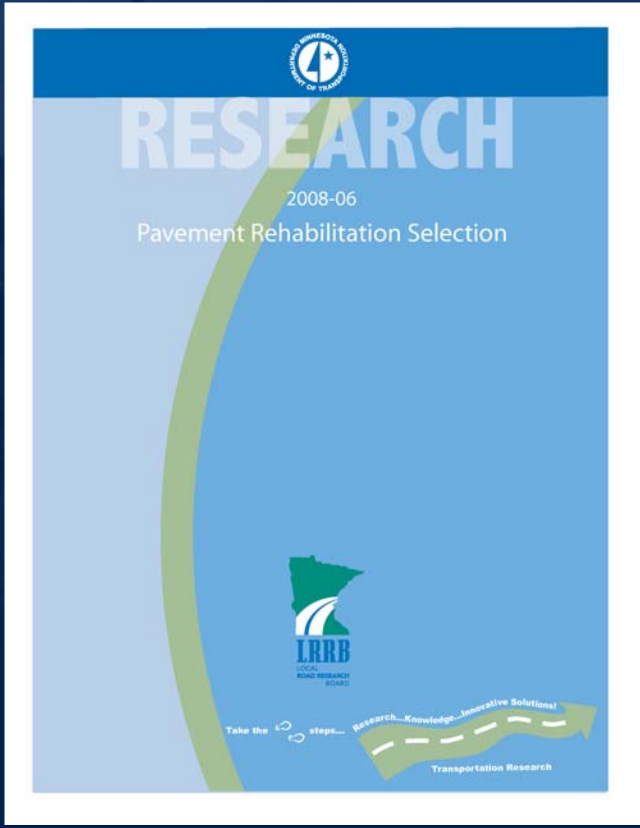
All Severities: Structural rehabilitation including:
1. Overlay
2. Mill and overlay
3. Recycling
4. Reconstruction

Rehabilitation Alternatives for ***each Severity Level***

Rehabilitation Selection Investigation 808

Investigation 808 Summary

- Types of Reclamation
- Decision Factors
- Database Development
- Decision Checklists
- Criteria
- Recommendations



Rehabilitation Selection Investigation 808

Selection Criteria

1. Is existing HMA thickness adequate to support CIR equipment (3.5 in.)?
2. Is existing subgrade stiffness adequate to support CIR equipment (5000 psi)?
3. Consider Surface Rating (SR) degradation rate.
4. If not structurally adequate then CIR should **NOT** be used without additional overlay.

Rehabilitation Selection Investigation 808

Selection Criteria (Continued)

5. If SR < 2.5 and multiple cracking or transverse cracking Individual Weighted Distress (IWD) > 5.0:
   - Mill and Overlay should not be used
     - If existing HMA > 3.5 in. use CIR or FDR
     - If existing HMA < 3.5 in. use FDR only

Rehabilitation Selection Investigation 808

NOTE:

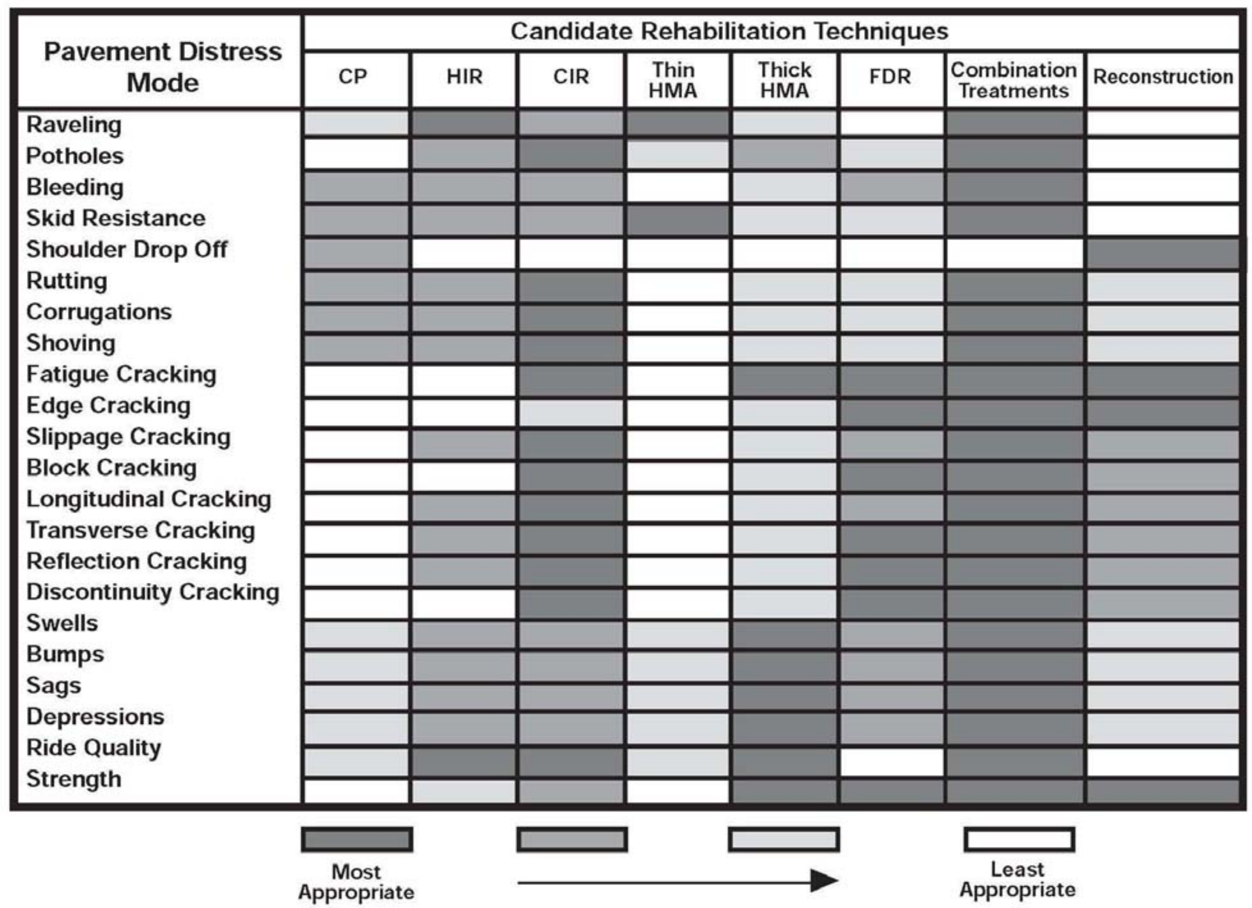
- An IWD = 5.0 for a pavement with all **medium** severity transverse cracks represents a crack count of 25 cracks per 500 ft.
- An IWD = 5.0 for a pavement with all **high** severity transverse cracks represents a crack count of 12 cracks per 500 ft.

Rehabilitation Selection Investigation 808

Selection Criteria (Continued)

6. If the SR < 2.5 and multiple or transverse cracking IWD is < than 5.0, use mill & overlay.
7. Finally, cost/benefits should be considered along with decay rates in the final decision.

Rehabilitation Selection Basic Asphalt Recycling Manual



Rehabilitation Selection

- Tools for Decision Making
  - Concrete Pavement
    - American Concrete Pavement Association -ACPA
      - Guide to Concrete Overlay Solutions
    - Mn/DOT Materials Office
    - Industry Input

Rehabilitation Selection
Guide to Concrete Overlay Solutions

Initial Evaluation (steps 1-3)

1 Pavement History

- Pavement material (including aggregate coefficient of thermal expansion), design, age, thickness, layers
- Existing traffic and performance level
- Design life
- Remaining life
- Desired traffic and performance level
- Desired design life
- Elevations and grade restrictions
- Etc.

2 Visual Examination

Concrete | Asphalt / Composite

Figure 9. Examples of existing pavement conditions

3 Core Analysis

- Depth of distress
- Type of distress
- Verification of thickness for base/subbase
- Etc.

4 Options

(depending on extent of problems)

4-a. Materials-Related Tests

(indicated by core analysis)

Conduct if

- Materials or durability issues are indicated
- Roadway provides high level of service), especially if a bonded overlay is being considered.

- Petrography analysis
  - Concrete material-related distress
  - Poor air-void system
- Asphalt stripping
- Coefficient of thermal expansion

4-b. Subsurface Tests

Conduct if

- Pavement or subgrade support issues are indicated
- Roadway provides high level of service), especially if a bonded overlay is being considered.

- Falling weight deflectometer tests
  - Subgrade support (*k* value)
  - Subgrade variability
  - Pavement properties
  - Load transfer efficiency
  - Presence of voids
  - Asphalt stiffness
  - Concrete flexural strength
- Subgrade tests
  - Freeze-thaw characteristics
  - Shrink-swell characteristics
  - Soil strength (dynamic cone penetration or standard penetration test)

4-c. Surface Texture Tests

Conduct if

- Materials or durability issues are indicated
- Roadway provides high level of service), especially if a bonded overlay is being considered.

- International roughness index
- Friction (skid resistance) tests

5 Condition Assessment Profile

Concrete

Surface Deficiencies

- Friction loss
- Joint deterioration (low to medium)
- Map cracking (non-ASR)
- Popouts
- Noise
- Scaling
- Roughness (not distress related)
- Plastic shrinkage cracks
- Thermal shrinkage cracks
- Etc.

Structural Deficiencies

- Corner breaks
- Joint deterioration (severe)
- Tented panels
- Longitudinal cracking
- Pumping/faulting
- Punchout
- Materials-related distress (medium to severe)
- Transverse cracking
- Subgrade/Subbase Condition
- Etc.

Asphalt / Composite

Surface Deficiencies

- Bleeding/flushing
- Block cracking
- Friction loss
- Noise
- Corrugation
- Joint reflective cracking
- Roughness (not distress related)
- Rutting
- Weathering/raveling
- Shoving
- Slippage
- Etc.

Structural Deficiencies

- Fatigue (alligator) cracking
- Depressions
- Heaves
- Longitudinal cracking
- Potholes
- Transverse thermal cracking
- Rutting/shoving
- Subgrade /Subbase Condition
- Etc.

Condition Evaluation Report and Pavement Condition Rankings

Figure 9. Examples of existing pavement conditions, continued

Summary of Pavement Evaluation Process

The purpose of evaluating the existing pavement's condition is to collect details about any distresses and performance problems that currently exist, and their causes. This information helps the owner-agency determine if a pavement is a good candidate for a concrete overlay and, if so, the extent of spot repairs required before an overlay is constructed. The extent of repairs needed is an important factor in determining if/when either a bonded or unbonded overlay will be a cost-effective solution.

Evaluating the existing pavement's condition involves at least three steps:

1. The first step is to review the pavement's historical design and performance record: pavement thickness and other design attributes, mix materials and design, construction date and method, traffic loadings, design life, maintenance activities to date, etc.

   Along with looking at the historical records, this step should include recording future performance requirements, like expected traffic loadings and overlay design life.

   This step should include a determination of any elevation limits and/or grade restrictions that signal potential clearance issues for overlay construction.

2. The second step is a visual examination of the pavement's condition, noting visible surface and structural distresses.
3. The third step is a more thorough examination of the pavement structure through a core analysis. This step will identify distresses or performance problems that cannot be determined by a visual exam alone. Core analyses verify pavement thickness, the subgrade/subbase material and thickness, and the depth and perhaps type or cause of distresses.

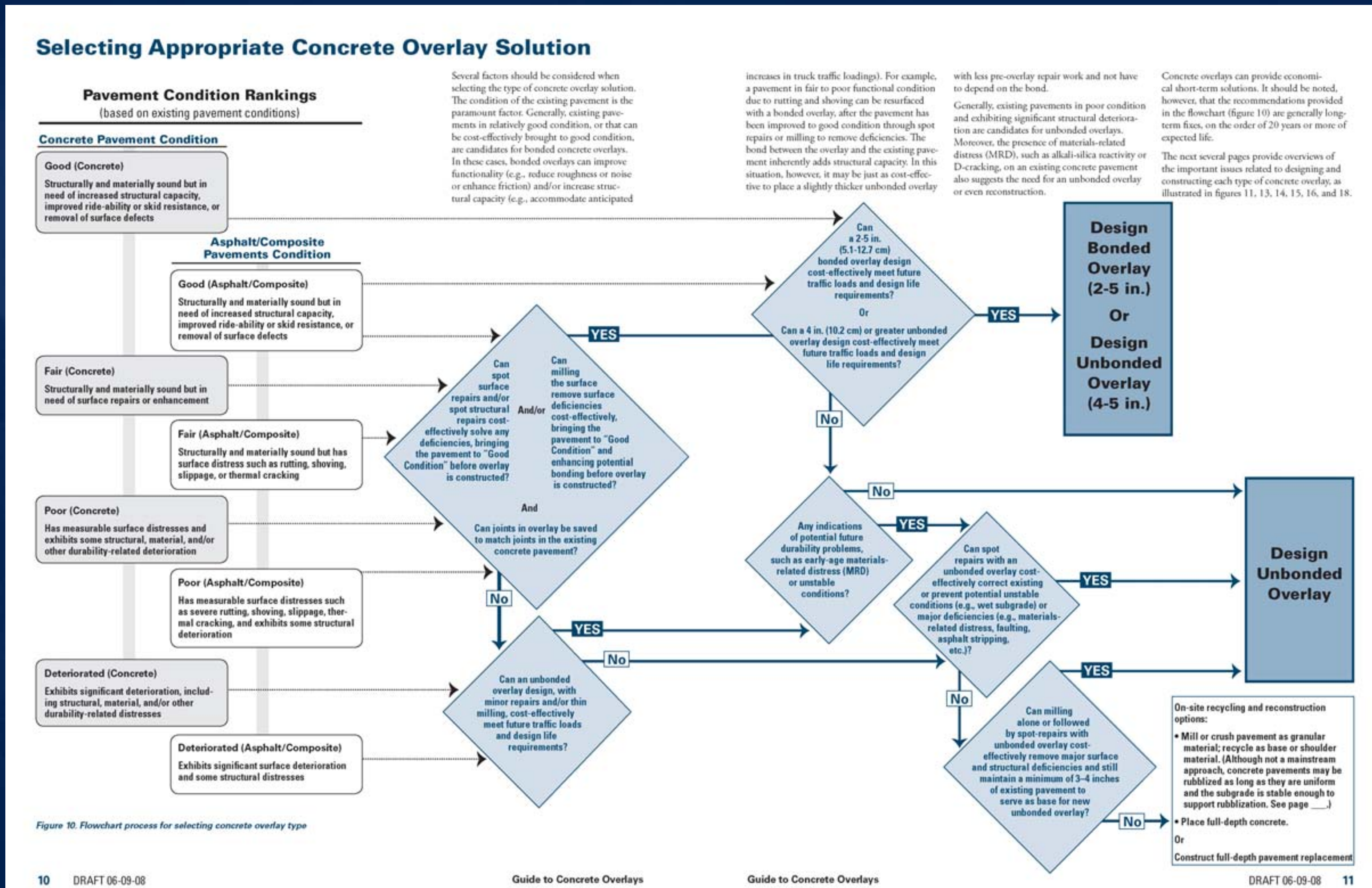
Based on information learned in steps 1–3, the necessity for additional evaluation should be considered. For example, tests related to materials or durability distresses, possible support problems, or surface conditions may be necessary. The following questions can help the pavement owner determine if additional tests are advisable:

- **What is the extent of pavement distresses**, based on the visual evaluation and core analysis?
- **What is the pavement's expected service level and life?** Pavements on major highways with significantly high truck volumes and/or long service life require more extensive and comprehensive evaluations than pavements on lower volume roadways.
- **Is a bonded or unbonded concrete overlay being considered?** Bonded overlays can represent some additional challenges compared to unbonded overlays.

Results from all evaluation steps should be recorded in a Condition Assessment Profile. This profile helps the agency determine the pavement's overall condition and summarize it in a Pavement Evaluation Report.

Pages 8 - 9

Rehabilitation Selection
Guide to Concrete Overlay Solutions



Selecting Appropriate Concrete Overlay Solution

Several factors should be considered when selecting the type of concrete overlay solution. The condition of the existing pavement is the paramount factor. Generally, existing pavements in relatively good condition, or that can be cost-effectively brought to good condition, are candidates for bonded concrete overlays. In these cases, bonded overlays can improve functionality (e.g., reduce roughness or noise or enhance friction) and/or increase structural capacity (e.g., accommodate anticipated increases in truck traffic loadings). For example, a pavement in fair to poor functional condition due to rutting and shoving can be resurfaced with a bonded overlay, after the pavement has been improved to good condition through spot repairs or milling to remove deficiencies. The bond between the overlay and the existing pavement inherently adds structural capacity. In this situation, however, it may be just as cost-effective to place a slightly thicker unbonded overlay with less pre-overlay repair work and not have to depend on the bond.

Generally, existing pavements in poor condition and exhibiting significant structural deterioration are candidates for unbonded overlays. Moreover, the presence of materials-related distress (MRD), such as alkali-silica reactivity or D-cracking, on an existing concrete pavement also suggests the need for an unbonded overlay or even reconstruction.

Concrete overlays can provide economical short-term solutions. It should be noted, however, that the recommendations provided in the flowchart (figure 10) are generally long-term fixes, on the order of 20 years or more of expected life.

The next several pages provide overviews of the important issues related to designing and constructing each type of concrete overlay, as illustrated in figures 11, 13, 14, 15, 16, and 18.

Figure 10. Flowchart process for selecting concrete overlay type

10 DRAFT 06-09-08 Guide to Concrete Overlays

Guide to Concrete Overlays DRAFT 06-09-08 11

Case Study #1

Case Study #1 Overview
Pavement History

- Two local roadways
- Built in 1993 using Mn/DOT Spec 2340 mix
  - 6” bit on one roadway
  - 8” bit on the other roadway
- Both roads received a chip seal between 1998 and 2001

Case Study #1 Overview
Pavement Condition

- The wearing course began debonding from the lower layers in the spring of 2008
  - A number of shallow potholes formed
- Potholes were milled and patched

Case Study #1 Overview
Pavement Strength Evaluation

- In-place and Rice Specific Gravity tests were performed on the bituminous wearing course
- Core densities ranged from 86% to 92%
- Extracted bituminous content was 6.0% in the good areas and 5.7% in the bad areas

Case Study #1 Overview
Surface, Base and Subgrade Analysis

- The chip seal has debonded from the underlying wearing course in areas showing surface distress
- There is stripping in the wearing course, causing the shallow potholes

Case Study #1 Overview Surface and Subsurface Drainage Review

- Curb and gutter is currently in place on both roadways and in good working condition
- There is evidence of moisture intrusion into the wearing course underlying the chip seal
  - Seen in the upper ½" of cores 3, 4 and 5

Case Study #1 Discussion

Case Study #1 Recommendations

- Major Considerations:
  – Age of pavement
  – Bituminous pavement deterioration
    - Limited to the wearing course

2” Mill and Inlay

Case Study #2

Case Study #2 Overview
Pavement History

- County State Aid Highway
- Constructed in 1989
  - 5” bituminous pavement
  - 12” aggregate base
  - Clay subgrade
- Constructed with a portion of roadway in the adjacent county
- Abuts a two mile portion of road built in 1941
  - 4” – 5” bituminous pavement (after several overlays)
  - 9” aggregate base

Case Study #2 Overview
Pavement Condition

- Surface condition rating is 3.40
  - Low to moderate transverse, longitudinal and fatigue cracks
- Surface condition rating of the abutting older roadway is 2.80

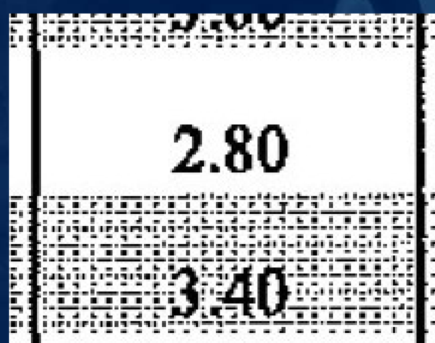
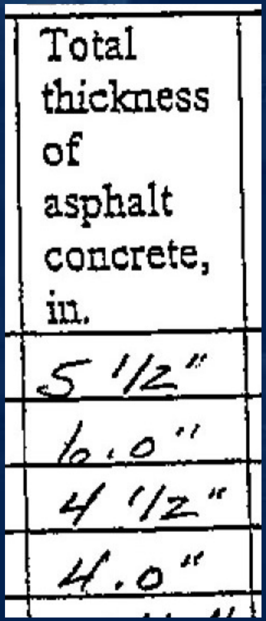


Table 2 - Deflection Analysis Results

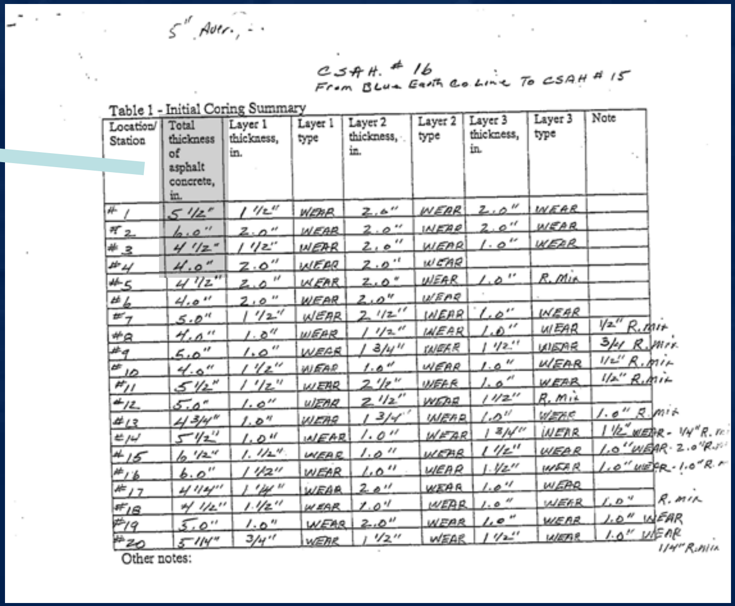
Roadway	Termini	Measured Section Length (miles)	Year of Top Asphalt Surface	20-year ESALs (*1000)	Analysis Input: Design Daily ESALs	Analysis Input: Surface Condition Rating	Analysis Input: Seasonal Correction Factor
CSAH 11	CSAH 12 - E. JCT CSAH 9	1.273	1983	131	13	2.40	1.43
CSAH 11	E. JCT. CSAH 9 - E. JCT. CSAH 2	3.497	1987	110	11	2.60	1.43
CSAH 11	E. JCT. CSAH 2 - W. JCT. CSAH 2	0.800	1987	319	32	2.80	1.43
CSAH 11	W. JCT. CSAH 2 - TH 99	3.047	1990	319	32	2.80	1.43
CSAH 15	TH 99 - TH 112	3.989	1999	270	27	3.00	1.25
CSAH 15	TH 112 - CSAH 26	4.021	1997	192	[illegible]	[illegible]	1.25
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39	2.80	1.25
CSAH 16	2265' E BEC 2 - BEC 2	[illegible]	[illegible]	401	39	3.40	[illegible]
CSAH 19	BEC 2 - [illegible]	3.556	1983	433	43	[illegible]	1.43
[illegible]	CR 144 - Rice County	2.043	--	433	43	2.50	1.25
CSAH 26	1000' W. CSAH 5 - 1000' E. CR 136	2.838	1993	282	28	3.70	1.25
CSAH 26	1000' E. CR 136 - 1325' W. TH 13	2.628	1985	478	47	2.60	1.43
CSAH 26	1325' W. TH 13 - TH 13	0.241	1985	478	47	3.20	1.43
CSAH 26	TH 112 - Park Lane	0.114	?	769	75	3.30	1.25
CSAH 26	Park Lane - E. City Limits	0.394	--	769	75	3.30	1.59
CSAH 26	E. City Lim. - 2100' E. City Lim.	0.400	1998	417	41	3.00	1.13
CSAH 26	2100' E. City Lim. - 8500' E. City Lim.	1.210	1998	417	41	3.00	1.43
CSAH 26	8500' E. City Lim. - CR 116	0.987	1998	417	41	3.00	1.13
CSAH 26	CR 116 - 1200' E. CSAH 15	1.664	1994	417	41	2.90	1.25
CSAH 28	CSAH 11 - CSAH 30	6.530	2000	213	21	4.80	1.25
CSAH 28	CSAH 30 - TH 13	2.021	1997	213	21	3.00	1.13
CSAH 33	CSAH 26 - CSAH 28	4.002	1990	102	10	3.00	1.25

Case Study #2 Overview Pavement Strength Evaluation Surface, Base and Subgrade Analysis

- From the coring report:
  - Surface thickness varies 4.0” to 6.0”



Total thickness of asphalt concrete, in.
5 1/2"
6.0"
4 1/2"
4.0"



5" Aver., - -

CSAH. # 16
From Blue Earth Co. Line To CSAH # 15

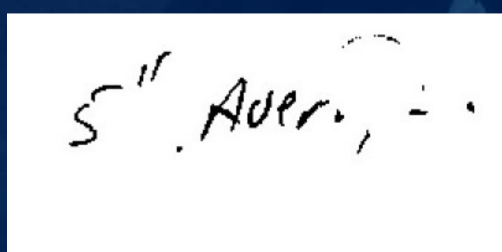
Table 1 - Initial Coring Summary

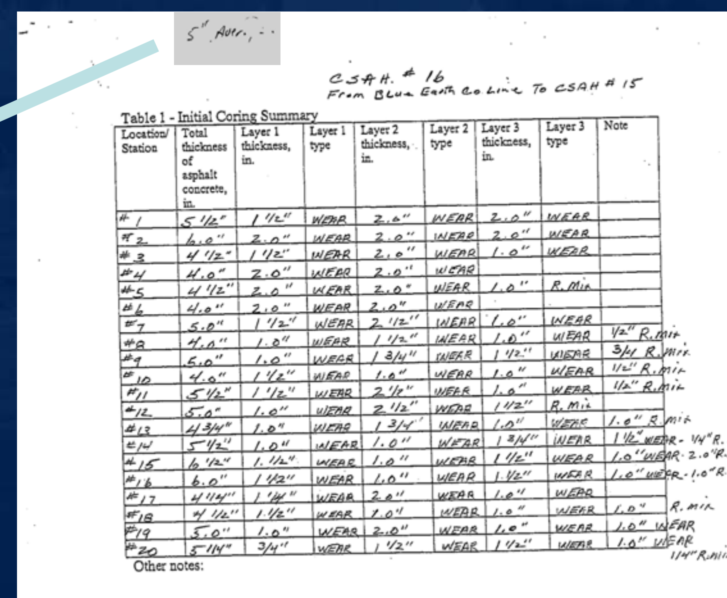
Location/ Station	Total thickness of asphalt concrete, in.	Layer 1 thickness, in.	Layer 1 type	Layer 2 thickness, in.	Layer 2 type	Layer 3 thickness, in.	Layer 3 type	Note
# 1	5 1/2"	1 1/2"	WEAR	2.0"	WEAR	2.0"	WEAR	
# 2	6.0"	2.0"	WEAR	2.0"	WEAR	2.0"	WEAR	
# 3	4 1/2"	1 1/2"	WEAR	2.0"	WEAR	1.0"	WEAR	
# 4	4.0"	2.0"	WEAR	2.0"	WEAR			
# 5	4 1/2"	2.0"	WEAR	2.0"	WEAR	1.0"	R. Mix	
# 6	4.0"	2.0"	WEAR	2.0"	WEAR			
# 7	5.0"	1 1/2"	WEAR	2 1/2"	WEAR	1.0"	WEAR	
# 8	4.0"	1.0"	WEAR	1 1/2"	WEAR	1.0"	WEAR	1/2" R. mix
# 9	5.0"	1.0"	WEAR	1 3/4"	WEAR	1 1/2"	WEAR	3/4 R. mix
# 10	4.0"	1 1/2"	WEAR	1.0"	WEAR	1.0"	WEAR	1/2" R. mix
# 11	5 1/2"	1 1/2"	WEAR	2 1/2"	WEAR	1.0"	WEAR	1/2" R. mix
# 12	5.0"	1.0"	WEAR	2 1/2"	WEAR	1 1/2"	R. Mix	
# 13	4 3/4"	1.0"	WEAR	1 3/4"	WEAR	1.0"	WEAR	1.0" R. mix
# 14	5 1/2"	1.0"	WEAR	1.0"	WEAR	1 3/4"	WEAR	1 1/2" WEAR - 1/4" R. mi
# 15	6 1/2"	1 1/2"	WEAR	1.0"	WEAR	1 1/2"	WEAR	1.0" WEAR - 2.0" R. m
# 16	6.0"	1 1/2"	WEAR	1.0"	WEAR	1 1/2"	WEAR	1.0" WEAR - 1.0" R. m
# 17	4 1/4"	1 1/4"	WEAR	2.0"	WEAR	1.0"	WEAR	
# 18	4 1/2"	1 1/2"	WEAR	1.0"	WEAR	1.0"	WEAR	1.0" R. mix
# 19	5.0"	1.0"	WEAR	2.0"	WEAR	1.0"	WEAR	1.0" WEAR
# 20	5 1/4"	3/4"	WEAR	1 1/2"	WEAR	1 1/2"	WEAR	1.0" WEAR 1/4" R. mix

Other notes:

Case Study #2 Overview Pavement Strength Evaluation Surface, Base and Subgrade Analysis

- From the coring report:
  - Surface thickness varies 4.0" to 6.0"
  - Average surface thickness is 5"





5" Aver.

CSAH. # 16
From Blue Earth Co. Line To CSAH # 15

Table 1 - Initial Coring Summary

Location/ Station	Total thickness of asphalt concrete, in.	Layer 1 thickness, in.	Layer 1 type	Layer 2 thickness, in.	Layer 2 type	Layer 3 thickness, in.	Layer 3 type	Note
# 1	5 1/2"	1 1/2"	WEAR	2.0"	WEAR	2.0"	WEAR	
# 2	6.0"	2.0"	WEAR	2.0"	WEAR	2.0"	WEAR	
# 3	4 1/2"	1 1/2"	WEAR	2.0"	WEAR	1.0"	WEAR	
#4	4.0"	2.0"	WEAR	2.0"	WEAR			
#5	4 1/2"	2.0"	WEAR	2.0"	WEAR	1.0"	R. Mix	
#6	4.0"	2.0"	WEAR	2.0"	WEAR			
#7	5.0"	1 1/2"	WEAR	2 1/2"	WEAR	1.0"	WEAR	
#8	4.0"	1.0"	WEAR	1 1/2"	WEAR	1.0"	WEAR	1/2" R. mix
#9	5.0"	1.0"	WEAR	1 3/4"	WEAR	1 1/2"	WEAR	3/4 R. mix
#10	4.0"	1 1/2"	WEAR	1.0"	WEAR	1.0"	WEAR	1/2" R. mix
#11	5 1/2"	1 1/2"	WEAR	2 1/2"	WEAR	1.0"	WEAR	1/2" R. mix
#12	5.0"	1.0"	WEAR	2 1/2"	WEAR	1 1/2"	R. Mix	
#13	4 3/4"	1.0"	WEAR	1 3/4"	WEAR	1.0"	WEAR	1.0" R. mix
#14	5 1/2"	1.0"	WEAR	1.0"	WEAR	1 3/4"	WEAR	1 1/2" WEAR - 1/4" R.
#15	6 1/2"	1 1/2"	WEAR	1.0"	WEAR	1 1/2"	WEAR	1.0" WEAR - 2.0" R.
#16	6.0"	1 1/2"	WEAR	1.0"	WEAR	1 1/2"	WEAR	1.0" WEAR - 1.0" R.
#17	4 1/4"	1 1/4"	WEAR	2.0"	WEAR	1.0"	WEAR	
#18	4 1/2"	1 1/2"	WEAR	1.0"	WEAR	1.0"	WEAR	1.0" R. mix
#19	5.0"	1.0"	WEAR	2.0"	WEAR	1.0"	WEAR	1.0" WEAR
#20	5 1/4"	3/4"	WEAR	1 1/2"	WEAR	1 1/2"	WEAR	1.0" WEAR 1/4" R. Mix

Other notes:

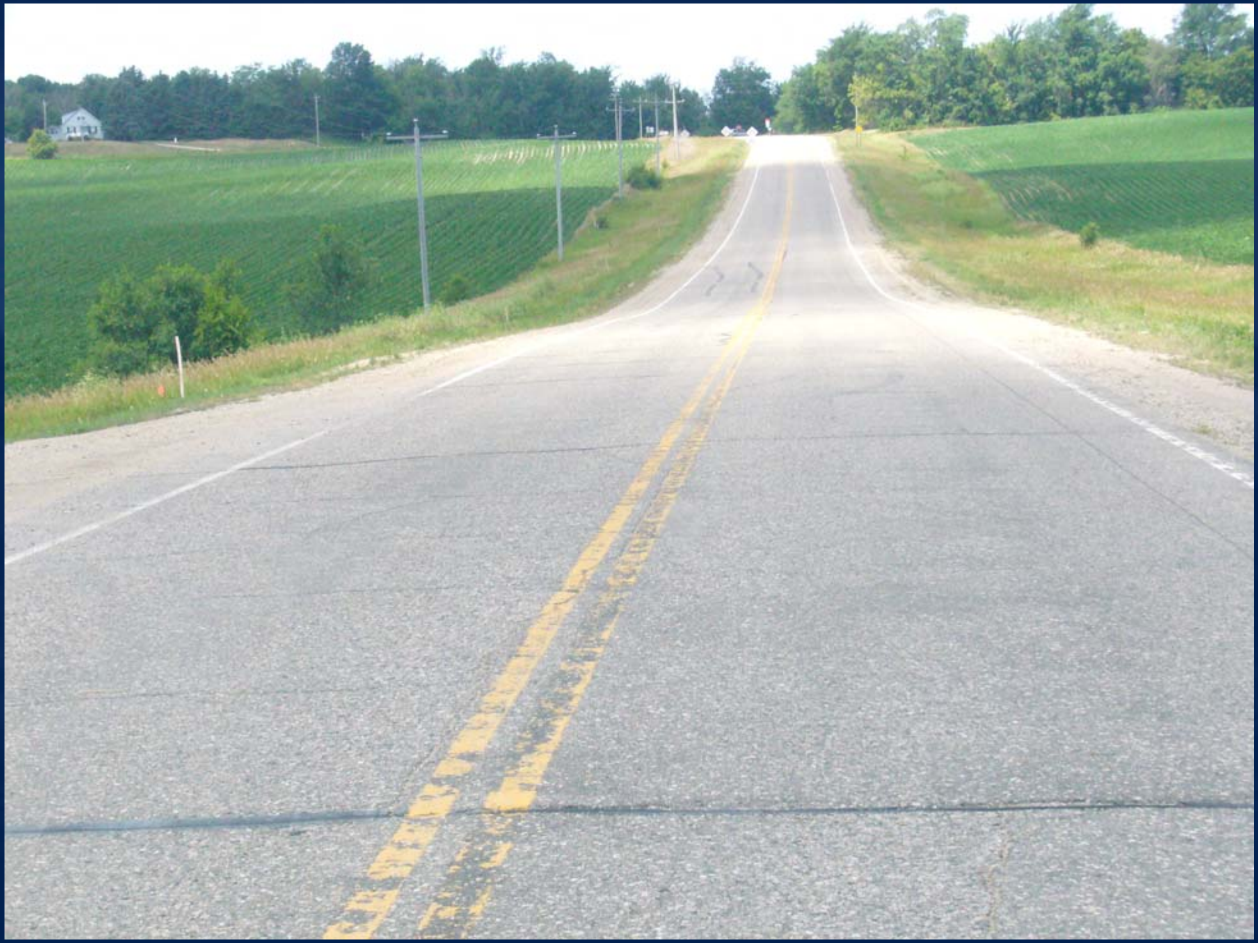
Case Study #2 Overview
Pavement Strength Evaluation
Surface, Base and Subgrade Analysis

- Spring Season Axle-Load
  - – Posting = 9 tons/axle
  - – Capacity = 8.3 tons/axle
- Deflection Analysis Results:
  - – Effective Subgrade R-value = 7.4
- Structural Analysis Results:
  - – Reported GE = 23.2 inches
  - – Effective GE = 21.0 inches
  - – Mn/DOT Design GE = 30.4 inches

Case Study #2 Overview Surface and Subsurface Drainage Review

- Ditches are in-place
- Roadway appears to be draining adequately

Case Study #2 Discussion



Case Study #2 Recommendations

- Major Consideration:
  - The performance of overlays throughout the history of the abutting older pavement
    - Cracks have propagated through the overlays at a rapid rate
    - Using CIR in similar situations has produced better results on other County projects

Case Study #2 Recommendations

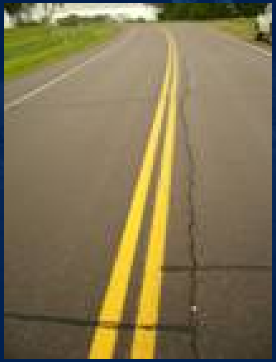
- Engineered Cold In-place Recycling
  - Recycle 4” of the original bituminous pavement
  - Surface with 3” of bituminous pavement
  - Drain tile

Case Study #2 Comparisons

- Different approaches taken by the two counties with this roadway:
  - County #1 chose CIR option in 2004
    - 8 low severity transverse cracks within first 8/10th of a mile (2008)

Case Study #2 Comparisons

– County #2 chose 2” Mill and Overlay option in 2005 with Seal Coat in 2006
  - Over 300 low to moderate transverse cracks and numerous longitudinal and fatigue cracks within first 8/10th of a mile (2008)



Case Study #3

Case Study #3 Overview
Pavement History

- Low volume, rural trunk highway
- Built as a gravel road in 1934
- Reconstructed in 1955
  - 1.5” bituminous wearing course over 6” of soil-cement treated base
- 2.75” bituminous overlay placed in 1973

Case Study #3 Overview
Pavement Condition

- Severe pavement deterioration
  - Rutting >1.5” deep

Case Study #3 Overview
Pavement Strength Evaluation
Surface, Base and Subgrade Analysis

- Preliminary deflection testing indicated the in-place subgrade to be very wet and unstable

Case Study #3 Overview Surface and Subsurface Drainage Review

- Subgrade consists of 2’ of ditch soil placed under roadway
  - Organic silt loam soils
  - Poor drainage and wet, weak subgrade year round

Case Study #3 Discussion

Case Study #3 Comparisons

- Test sections were constructed in 1993
  - 2 bituminous overlay sections
    - Test Section 1 – 3” thickness
    - Test Section 2 – 5” thickness
  - 4 whitetopping sections
    - Test Section 3 – 6” thickness, bonded, undoweled
    - Test Section 4 – 6” thickness, bonded, doweled
    - Test Section 5 – 6” thickness, bonded, undoweled
      - HMA milled for even surface
    - Test Section 6 – 6” thickness, unbonded, undoweled
- Edge drains were installed along all the test sections

Case Study #3 Comparisons

- Bituminous Overlay Maintenance:
  - – Transverse and longitudinal cracks were routed and sealed in 1997
  - – Chip seal applied in 2000
- Whitetopping Maintenance:
  - – No maintenance has been performed on the whitetopping sections through 2007

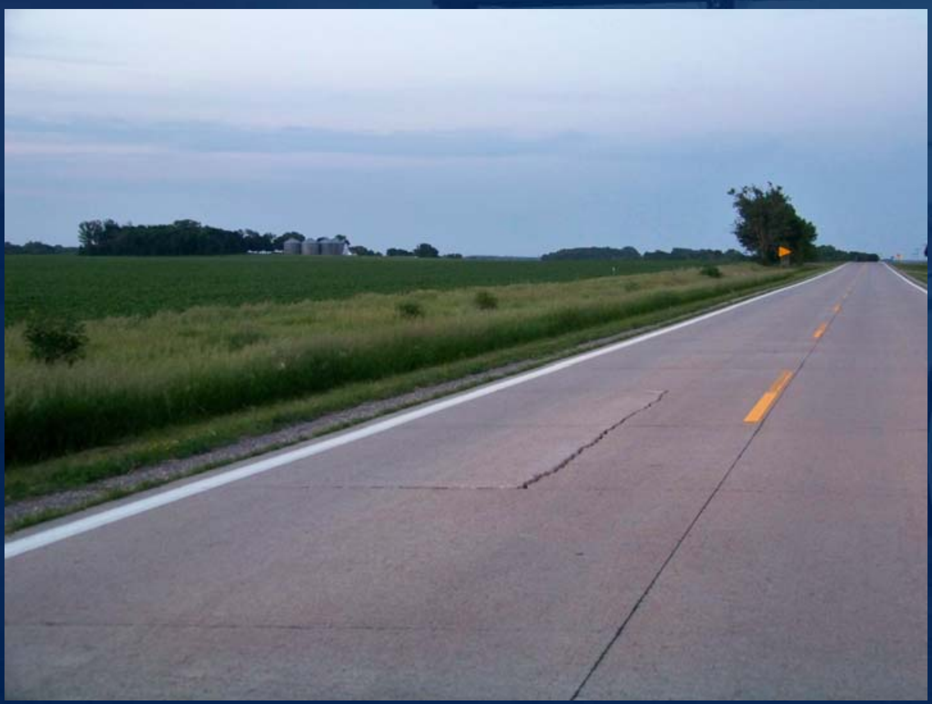
Case Study #3 Comparisons

- 3” Bituminous Overlay
  - Crack spacing is 15 – 20’

Case Study #3 Comparisons

- 5” Bituminous Overlay
  - Crack spacing is 50’

Case Study #3 Comparisons



- 6” Whitetopping
  - Bituminous surface was milled before placement
  - Bonded
  - Undoweled
- Only required maintenance has been patching over settled culverts
- Some longitudinal cracking

Case Study #3 Recommendations

- Proposed Design:
  - 6” Whitetopping
    - Milled bituminous surface for uniform thickness
    - Bonded
    - Undoweled
  - Edge drains along the roadway
    - Will reduce subgrade instability and extend the life of the pavement

Case Study #3 Recommendations

TH 30 Total Construction Costs for Pavement and Shoulders (1993 dollars)

Test Section	Special Items Included	Bid Price/mile	As-built Price/mile
1		$68,728	$76,972
2		$126,596	$134,852
3 (control)		$141,766	$154,023
4	dowels	$168,724	$180,885
5	milling	$148,806	$161,063
6	curing compound	$143,034	$155,290

1 mile = 1.6 km

Case Study #3 Recommendations

Equivalent Uniform Annual Costs

Test Section	Thickness and type	Estimated Life (yrs)	EUAC[a]	
			With maintenance	No maintenance
1	3 inch hot-mix asphalt overlay	10	$10,487	$9,023
2	5 inch hot-mix asphalt overlay	15	$12,342	$11,296
3 (control)	5 inch minimum (6 in. avg) bonded undoweled PCC overlay	20	$10,353	
4	5 inch minimum (6 in. avg) bonded doweled PCC overlay	20	$12,158	
5	6 inch bonded undoweled PCC overlay	20	$10,826	
6	5 inch minimum (6 in. avg) unbonded undoweled PCC overlay	20	$10,438	

1 inch = 25.4 mm a) Annual inflation rate = 3.0%

Case Study #3 Recommendations

- Although all sections are in good condition (2002), this proposed design:
  - Is the most economical design to date
  - Has required no maintenance to date
  - Has a better ride quality than the other sections