Chapter

5

Signs of Pavement and Bridge Distress and Fix Selection Guidelines

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Introduction

This chapter is intended as a general guideline, for which fixes are appropriate for the various distresses on Michigan's pavements. Although many of the fixes listed have been successful, they may not apply in all cases. Determining the treatment to use in rehabilitating a particular segment of highway is primarily a matter of engineering judgment. Progress has been made in quantifying certain intangibles, matching structural numbers with proposed traffic volumes and calculating cost/benefit analyses, but the major factor remains - engineering judgment.

The contents of this chapter include information, text, diagrams and guidance documentation referenced from the US Department of Transportation Federal Highway Administration Manual named, "Distress Identification Manual for the Long-Term Pavement Performance Program (Publication No. FHWA-RD-03-031, June 2003)".

Signs of Pavement Distress

Michigan has three pavement types; flexible, rigid and composite. Flexible pavements are constructed using hot mix asphalt (HMA) mixtures, which are typically placed on a combination of granular and dense graded aggregate bases.

Rigid pavements are constructed using concrete mixtures, which are commonly placed on a combination of dense graded aggregate bases and granular bases or on open graded aggregate bases and granular bases. Rigid pavements have unique qualities. The concrete may be plain or reinforced with steel wire fabric reinforcement. Additionally, rigid pavement is poured with joints to allow for contraction and expansion of the concrete. Joint spacing can vary from trunkline to trunkline.

Composite pavements are HMA mixtures placed on a rigid pavement.

The following provides examples of common distresses and potential fixes for pavements with various type of distresses. It should be noted that some of the fixes can address the distress itself while others will address the pavement as a whole. In most cases, it is assumed that the distress is prevalent throughout the pavement section and not an isolated location. All of the types of distresses in a given section of pavement will need to be considered when choosing a fix.

Flexible Pavement

Primary types of distress associated with flexible pavements are transverse cracking, longitudinal cracking, block cracking, fatigue or

alligator cracking, rutting, raveling, shoving and flushing. A description and cause of each, with possible fixes are as follows:

Transverse Cracking

Description

Transverse cracks are predominantly perpendicular to the pavement centerline. Cracks are often regularly spaced and are caused by the movement of the pavement due to temperature changes and hardening of the asphalt with age.

Severity Levels

Low Severity Description: A low severity transverse crack is defined as an unsealed crack, with a mean width of ¼ inch or less or a sealed crack with sealant material in good condition and indeterminate width.

Possible Fix Options:
- Cut and Seal
- Overband Crack Fill
- Chip Seal
- Microsurface
- HMA Ultra-thin Overlay

Moderate Severity Description: A moderate severity transverse crack has a mean width of ¼ to ¾ inches or is any crack with a mean width of ¾ inches or less and adjacent low severity random cracking.

Possible Fix Options:
- Overband Crack Fill
- HMA Patch
- Chip Seal
- Microsurface
- HMA Ultra-thin Overlay
- Mill and Resurface
- Crush and Shape
- HMA Overlay with or without Repairs

High Severity Description: A high severity transverse crack is wider than ¾ inch on average or has a mean width of ¾ inches or less with adjacent moderate to high severity random cracking.

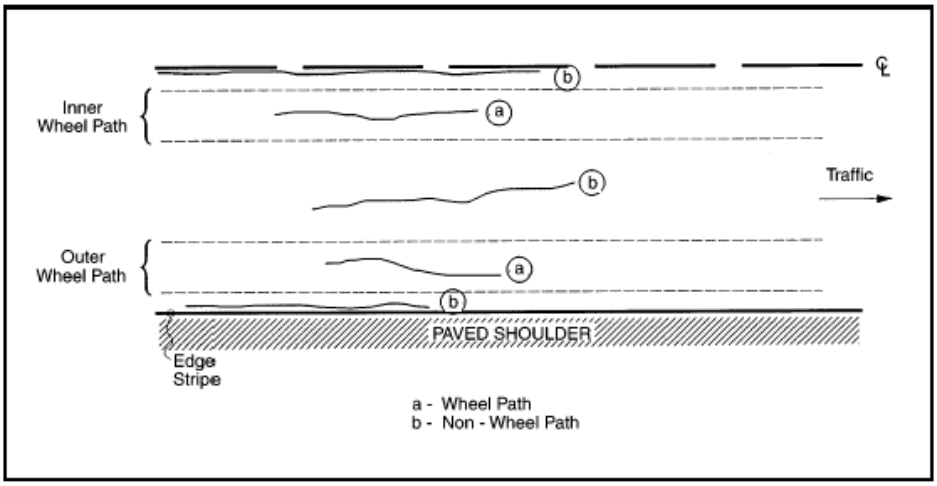
Possible Fix Options:
- Mill and Resurface
- Crush and Shape
- HMA Overlay with Repairs
- Reconstruct

Longitudinal Cracking

Description

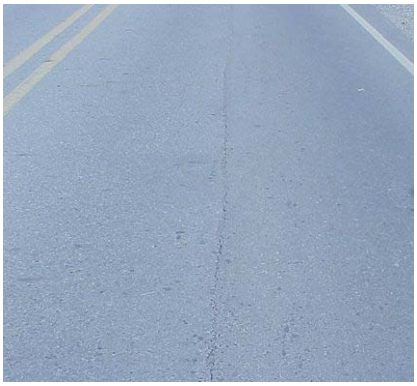
Longitudinal cracks are predominantly parallel to the pavement centerline (wheel path ⓐ versus non-wheel path ⓑ). These cracks are especially significant if they are within the wheel path. Any wheel path longitudinal crack that has associated random cracking is rated as fatigue cracking, which is considered a major structural distress in flexible pavements. See "Fatigue Cracking" on page 5-7 for more information.

In flexible pavement, probable causes include a poorly constructed paving lane joint, shrinkage of the asphalt due to temperature changes, hardening of the asphalt and/or reflective cracks beneath the surface course.



Severity Levels

Low Severity Description: A low severity longitudinal crack has a mean width of less than ¼ inch or is a sealed crack of indeterminate width with sealant in good condition.



Possible Fix Options:
- Cut and Seal
- Overband Crack Fill
- Chip Seal
- Microsurface
- HMA Ultra-thin Overlay

Moderate Severity Description: A crack, with an average width of greater than ¼ inch to less than or equal to ¾ inch or any crack with a mean width less than or equal to ¾ inch and adjacent low severity random cracking.

Possible Fix Options:
- Overband Crack Fill
- Chip Seal
- Microsurface
- HMA Ultra-thin Overlay
- Mill and Resurface
- Crush and Shape
- Overlay with or without Repairs

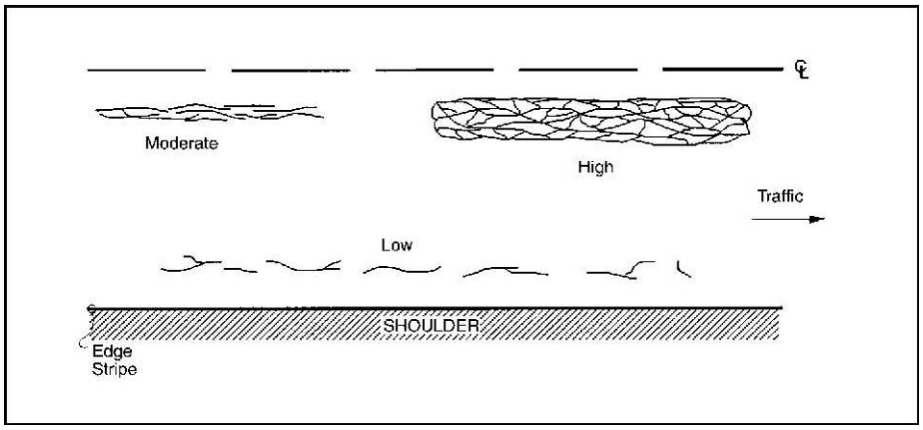
High Severity Description: A crack width > ¾ inch or any crack with a mean width ≤ ¾ inch and adjacent moderate to high severity random cracking.

Possible Fix Options:
- Mill and Resurface
- Crush and Shape
- Overlay with Repairs
- Reconstruct

Fatigue Cracking (or Alligator Cracking)

Description

Fatigue cracking occurs in areas that are subjected to repeated traffic loadings (wheel paths). It can be a series of interconnected cracks in early stages of development. The cracks may develop into many-sided, sharp-angled pieces, usually less than one foot on the longest side, characteristically with a chicken wire/alligator pattern, in later stages. In flexible pavement the pattern must have a quantifiable area. The cracking is caused by fatigue failure of the asphalt concrete surface under repeated traffic loading.



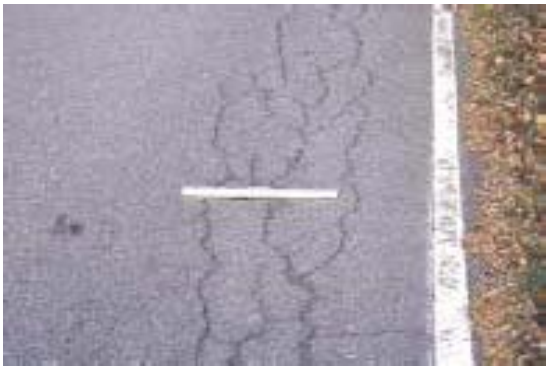
Severity Levels

Low Severity Description: An area of cracks, with no or only a few connecting cracks, cracks are not spalled or sealed and pumping is not evident.

Possible Fix Options:
- Cut and seal
- Overband crack fill
- Chip seal
- Microsurface
- HMA Ultra-thin Overlay
- Patching

Moderate Severity Description: An area of interconnected cracks, forming a complete pattern, cracks may be slightly spalled, cracks may be sealed and pumping is not evident.

Possible Fix Options:
- Chip Seal
- Microsurface
- HMA Ultra-thin Overlay
- Mill and Resurface
- Patching



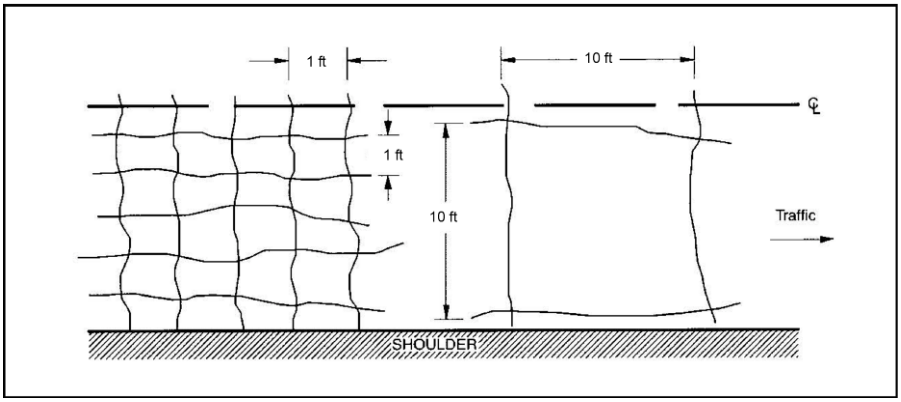
High Severity Description: An area of moderately or severely spalled interconnected cracks forming a complete pattern, pieces may move when subjected to traffic, cracks may be sealed and pumping may be evident.

Possible Fix Options:
- Mill and Resurface
- Crush & Shape
- Reconstruction

Block Cracking

Description

In flexible pavement, block cracking is a pattern which divides the pavement into pieces that are approximately rectangular. These rectangular blocks range in size from about one square foot to one hundred square feet.



Severity Levels

Low Severity Description: Cracks with a mean width ≤ ¼ inch or sealed cracks with sealant material in good condition and with a width that cannot be determined.

Possible Fix Options:
- Chip Seal
- HMA Ultra-thin Overlay

Moderate Severity Description: Cracks with a mean width > ¼ inch and ≤ ¾ inch or any crack with a mean width ≤ ¾ inch and adjacent low severity random cracking.

Possible Fix Options:
- Mill and Resurface
- Crush and Shape
- Overlay without Repair
- Reconstruct

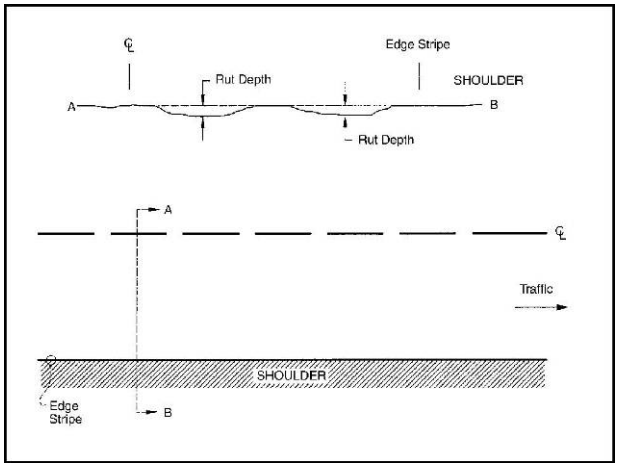
High Severity Description: Cracks with a mean width > ¾ inch or any crack with a mean width ≤ ¾ inch and adjacent moderate to high severity random cracking.

Possible Fix Options:
- Mill and Resurface
- Crush and Shape
- Reconstruct

Rutting

Description

Rutting is the formation of longitudinal depressions in the wheel paths that result when an HMA pavement or underlying base has insufficient stability to support traffic. It usually appears as two continuous wheel "tracks" in the traveled lane, sometimes only visible during a rain or when measured with a straightedge.



How to determine the cause of the problem based on rutting shape

The shape of the rut can be an indicator of the cause. Rutting due to HMA mix instability will have gently sloping sides and a rounded bottom. The HMA may also be “humped up” next to the rut. Rutting due to poor support will have sides that drop abruptly and a flatter bottom.

How to determine the correct fix based on the cause of the problem

Possible Fix Options:

- For rutting due to HMA mix instability, a mill and resurface of affected layers will typically address the problem.
- For rutting due to poor support, a reconstruct is recommended, although a mill and resurface can temporarily restore the pavement to a smooth surface.
- Other options include microsurface with rut fill preparation and crush and shape.

Raveling

Description

Raveling is the wearing away of the pavement surface, caused by the dislodging of aggregate particles and loss of asphalt binder. Raveling ranges from the loss of fines to the loss of some coarse aggregate and ultimately to a very rough and pitted surface with obvious loss of aggregate.

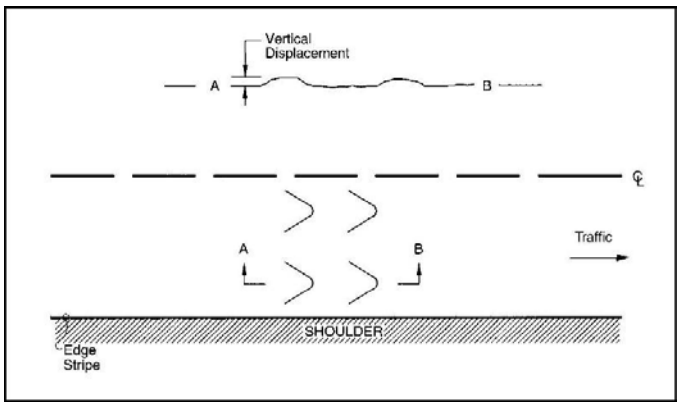
Possible Fix Options:

- Low to medium raveling (surface texture is low to moderately rough and pitted) can be addressed with a surface seal
- High amount of raveling (surface texture is severely rough and pitted) can be addressed with cold milling and resurfacing

Shoving

Description

Shoving is a longitudinal displacement of a localized area of the pavement surface. It is generally caused by braking or accelerating vehicles, and is usually located on hills, curves or intersections. It also may have associated vertical displacement.



Possible Fix Options:

- Cold milling and resurfacing with either a high stress HMA mixture or concrete white topping

Flushing

Description

Flushing is the excess of bituminous binder, occurring on the pavement surface, usually found in the wheel paths. It may range from a surface discolored relative to the remainder of the pavement, to a surface that is losing surface texture because of excess asphalt, to a condition where the aggregate may be obscured by excess asphalt possibly with a shiny, glass-like, reflective surface that may be tacky to the touch.

Possible Fix Options:
- Chip Seal
- Microsurface
- HMA Overlay (ultra-thin or one-course)
- Mill and Resurface

Pumping

Description

Pumping is the seeping or ejection of water from beneath the pavement through cracks. In some cases, detectable by deposits of fine material left on the pavement surface, which were eroded (pumped) from the support layers and have stained the surface.

Possible Fix Options:
- Joint/Crack Sealing
- Full Depth Repair/Replace
- Underdrain Retrofit

Rigid Pavement

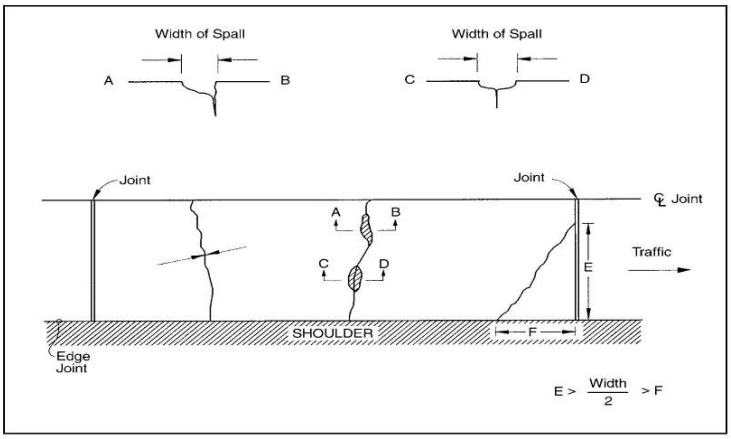
This section describes distresses in Jointed Plain Concrete Pavement (JPCP) and Jointed Reinforced Concrete Pavement (JRCP). Since most Continuously Reinforced Concrete Pavement (CRCP) in Michigan has been removed or resurfaced, it will not be discussed in this section. If a CRCP is in need of repair, consult with the Construction and Technology Division for recommendations.

Typical distresses in JPCP and JRCP pavements are transverse cracking, longitudinal cracking, joint faulting, joint spalling, mid-slab spalling, joint seal failure and pumping.

Transverse Cracking

Description

Transverse cracking is predominantly perpendicular to the pavement centerline. In rigid pavement, these are often caused by a combination of heavy load repetition, thermal and moisture gradient stresses and drying shrinkage stresses.



Severity Levels

Low Severity Description: Crack widths < 1/8 inch, no spalling and no measurable faulting or well-sealed and the width cannot be determined.

Possible Fix Options:
- No repair (if it is very tight)
- Cut and Seal
- Dowel Bar Retrofit
- Full-Depth Repair

Moderate Severity Description: Crack widths ≥ 1/8 inch and < ¼ inch, with spalling < 3 inches or faulting up to ¼ inch.

Possible Fix Options:
- Dowel Bar Retrofit
- Full-Depth Repair
- Diamond Grinding
- Overlay
- Reconstruct

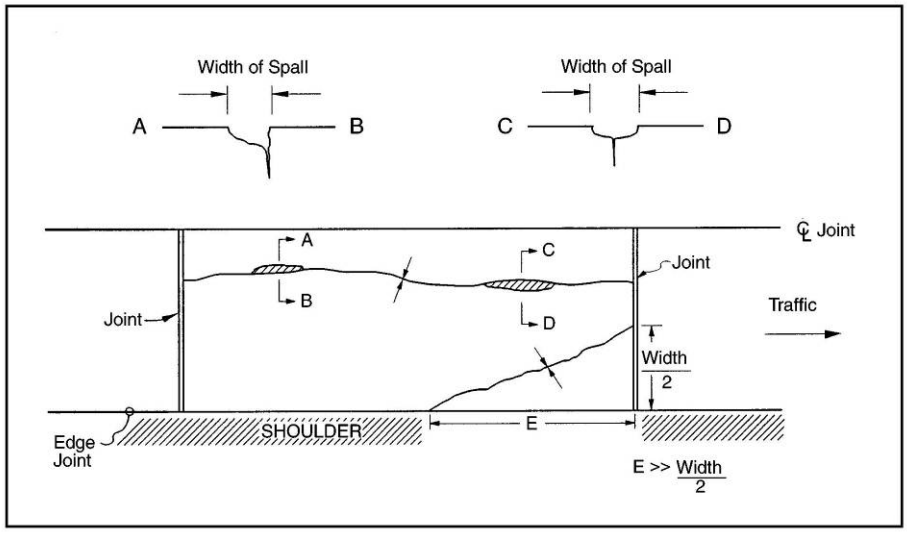
High Severity Description: Crack widths ≥ ¼ inch, with spalling ≥ 3 inches or faulting ≥ ¼ inch.

Possible Fix Options:
- Full-Depth Repair
- Overlay
- Reconstruct

Longitudinal Cracking

Description

Longitudinal cracking is predominantly parallel to the pavement centerline. In rigid pavement, causes may be improper construction of longitudinal joints, a combination of heavy load repetitions, loss of foundation support, thermal and moisture gradient stresses and inappropriate design of tie bars.



Severity Levels

Low Severity Description: Crack widths < 1/8 inch, no spalling and no measurable faulting, or well-sealed and with a width that cannot be determined.

Possible Fix Options:
- Cut and Seal
- Remove and Replace
- Cracked Slabs

Moderate Severity Description: Crack widths ≥ 1/8 inch and < ½ inch, with spalling < 3 inches or faulting up to ½ inch.

Possible Fix Options:
- Remove and Replace Cracked Slabs
- Overlay
- Reconstruct

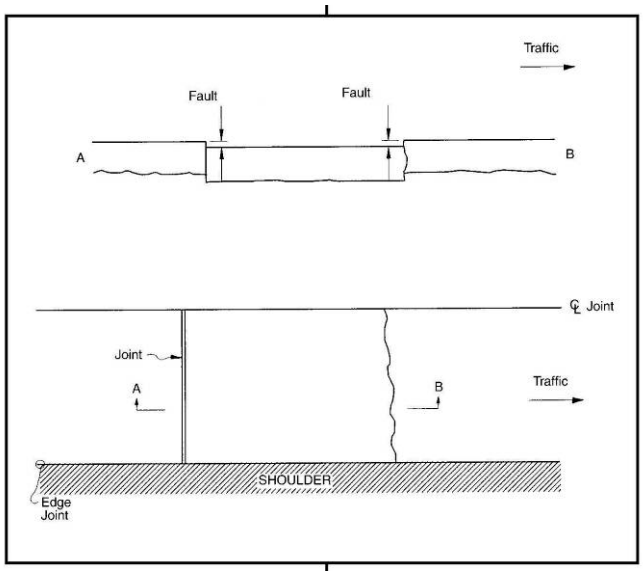
High Severity Description: Crack widths ≥ ½ inch, with spalling ≥ 3 inches or faulting ≥ ½ inch.

Possible Fix Options:
- Remove and Replace Cracked Slabs
- Overlay
- Reconstruct

Joint Faulting

Description

Joint faulting occurs in rigid pavement only and is the difference in elevation across a joint or crack. It is usually an indicator of loss of support and can be located at the transverse or longitudinal joints. This may be caused by the buildup of loose material under the approach slab and depression in the leave slab or curling and warping of the concrete slab.



Severity Levels

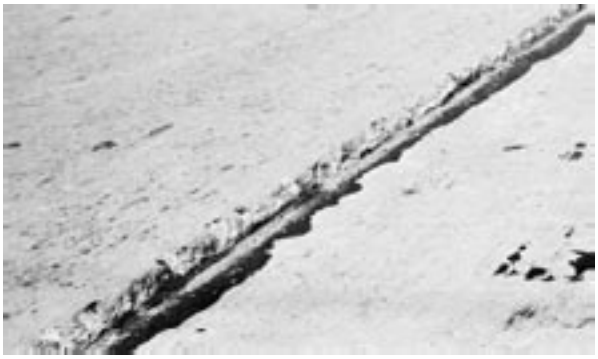
Low Severity Descriptions: Average faulting is < ¼ inch.

Possible Fix Options:
- Full Depth Repair
- Diamond Grinding

Moderate Severity Description: Average faulting is ≥ ¼ inch and < ½ inch.

Possible Fix Options:
- Jacking
- Full-Depth Repair
- Diamond Grinding
- Overlay
- Reconstruct

High Severity Description: Average faulting is ≥ ½ inch.



Possible Fix Options:
- Jacking
- Full Depth Repair
- Overlay
- Reconstruct

Joint Spalling

Description

Joint Spalling occurs in rigid pavement only and is the cracking, breaking, chipping or fraying of slab edges along the face of a longitudinal or transverse joint. A joint spall usually does not extend vertically through the whole slab thickness, but intersects the joint at an angle. Joint Spalling usually results from excessive stresses at the joint caused by infiltration of incompressible materials and subsequent expansion, freezing and thawing water, or by traffic loading. Also, a poorly designed or constructed load transfer device can contribute to joint spalling.

Severity Levels

The size of a joint spall is determined from the following criteria:

Small Spall = less than three inches along the joint and less than one inch from face of joint

Medium Spall = three to twelve inches along the joint and within one to three inches from face of joint

Large Spall ≥ twelve inches along the joint and > three inches away from face of joint

Low Severity Description: A joint with an occasional small or medium spall.

Possible Fix Options:
- No Fix
- Joint Spall Repair

Moderate Severity Description: A joint with nearly a continuous small spalling, several medium spalls or one large spall.

Possible Fix Options:
- Joint Spall Repair
- Full Depth Repair

High Severity Description: A joint with many medium spalls and/or several large spalls.

Possible Fix Options:
- Full Depth Repair
- Full Depth Repair with an Overlay
- Reconstruct

Mid-Slab Spalling

Description

Mid-Slab Spalling occurs in rigid pavement only and is the breaking and/or loss of material at the surface, not immediately adjacent to one of the joints. Large pop-outs of material and corrosion of high reinforcing steel are two causes of mid-slab spalls.

Severity Levels

Low Severity Description: A spall less than ten square inches.

Possible Fix Options:
- Leave As Is
- Spall Repair

Moderate Severity Description: A spall > ten square inches, but < one hundred square inches.

Possible Fix Options:
- Spall Repair

High Severity Description: A spall > one hundred square inches.

Possible Fix Options:
- Spall Repair
- Full Depth Repair
- Spall Repair with an Overlay
- Reconstruct

Joint Seal Failure

Description

Description of "cohesive failure", "adhesive failure" and "compressive set"

Joint seal failure occurs in rigid pavement only and is either the tearing of the sealant (cohesive failure) or loss of adhesion to the joint side walls (adhesive failure). When adhesive failure occurs the sealant might get pulled out or drop down in the joint, due to adhesive and contact failure. Sometimes with preformed sealants, the sealant permanently compresses (takes a compression set) from the joint being closed tightly for extended periods. Compression set results in loss of contact with the joint walls. These failures enable incompressible materials or water to infiltrate the joint from the surface.

Severity Levels

Low Severity Description: Less than six inches of failure along the transverse joint length or less than five percent of failure along the longitudinal joint length.

Possible Fix Options:
- Leave As Is
- Joint Reseal

Moderate Severity Description: Six inches to three feet of failure along the transverse joint length or five to twenty percent of failure along the longitudinal joint length.

Possible Fix Options:
- Joint Reseal

High Severity Description: Greater than three feet of failure along the transverse joint length or greater than twenty percent of failure along the longitudinal joint length.

Possible Fix Options:
- Joint Reseal

Pumping

Description

Pumping is the seeping or ejection of water from beneath the pavement through cracks. It can occur in rigid and flexible pavements. In some cases, it is detectable by deposits of fine material left on the pavement surface, which were eroded (pumped) from the support layers and have stained the surface.

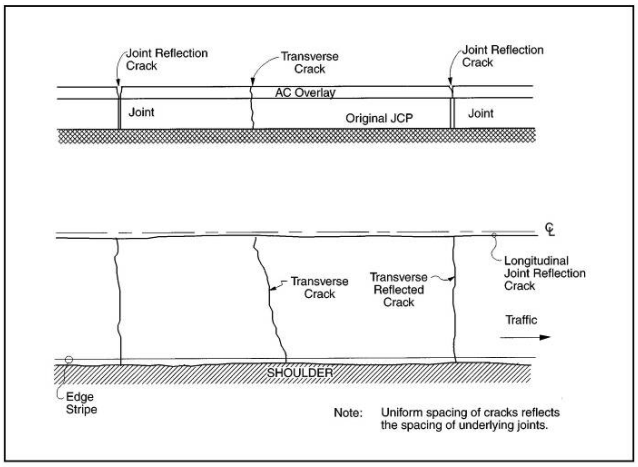
Possible Fix Options:
- Joint/Crack Sealing
- Full Depth Repair
- Underdrain Retrofit

Composite Pavement

Composite pavements consist of HMA over concrete or concrete over HMA. The most common in Michigan is HMA over concrete.

HMA Over Concrete

Distresses and recommended fixes for HMA over concrete pavements are the same as those for flexible pavements with the addition of joint reflective cracking from concrete slab and crush & shaping, respectively. In general, fix lives are lower and distress quantities are higher for composite pavements than for flexible pavements.



Reflective Cracking at Joints

Description

Reflective cracking at joints is unique to HMA over concrete pavements and includes all longitudinal and transverse cracks that appear on top of the concrete joints. Knowledge of the slab dimensions beneath the HMA surface will help identify these cracks. These cracks are caused by movements in the concrete slab beneath the HMA surface because of thermal and/or moisture changes. It is generally not load initiated distress. However, traffic loading may accelerate the deterioration of the cracks and may cause a breakdown of the HMA surface near the initial crack, resulting in spalling.

For severity levels and recommended fix options, see transverse cracking for flexible pavements (page 5-4).

Concrete over HMA

Distresses and recommended fixes for concrete over HMA are the same as those for rigid pavements (pages 5-13 to 5-23) with the exception that dowel bar retrofit is not recommended. This is due to the fact that concrete over HMA overlays are usually much thinner than 8 inches. It should also be noted that full-depth repairs are much more difficult in concrete overlays due to the bond between the concrete and HMA.

Road R&R Treatment Options

Rehabilitation and Reconstruction Fix Life Guidelines

CFP In each year's Integrated Call For Projects (CFP) Letter of Instructions a current Road Rehabilitation and Reconstruction Fix Life Guideline table is provided. Appendix A-3 has an example of this table.

The tables in Appendix A-1 show Recommended Corridor Pavement Management Strategies. These tables show possible work types for various pavements, based on existing pavement type, age of pavement and Commercial Average Daily Traffic (CADT) volumes. In addition, Work Type Codes (WTC) are given at the end of Appendix A-2.

Distress Index Based Fix Guidelines

The following tables provide Fix Guidelines for the three pavement types (flexible, rigid and composite) based on the pavement's current distress index (DI).

Table 5-1: Fix Guidelines for Flexible Pavement

Flexible	
DI Rating	Fix Options
< 15	Crack Treatment Micro-Surfacing (Single Course)
< 20	Overband Crack Filling Ultra-Thin Overlay
< 25	Single Chip Seal
< 30	Double Chip Seal Micro-Surfacing (Double Course) Micro-Surfacing (Heavy Single Course)
< 40	HMA Overlay HMA Mill & Overlay
> 50	Rehabilitation or Reconstruction

Table 5-2: Fix Guidelines for Rigid Pavement

Rigid	
DI Rating	Fix Options
< 10	Diamond Grinding
< 15	Joint Resealing Concrete Spall Repair Crack Sealing Dowel Bar Retrofit
< 20	Full Depth Concrete Pavement Repair
< 40	Concrete Pavement Restoration
> 50	Rehabilitation or Reconstruction

Table 5-3: Fix Guidelines for Composite Pavement

Composite	
DI Rating	Fix Options
< 5	Crack Treatment
< 10	Overband Crack Filling Ultra-Thin Overlay
< 15	Micro-Surfacing (Double or Heavy Single Course) Double Chip Seal
< 25	HMA Overlay
< 30	HMA Mill & Overlay
> 50	Rehabilitation or Reconstruction

Recommended Fix Guidelines for PASER Ratings

A Pavement Condition versus Pavement Age Curve and Ratings are shown on the graph below. The curve shows the rate that pavement condition deteriorates, as the pavement ages. The chart lists PASER ratings (Pavement Surface and Evaluation Ratings) and Maintenance Guidelines that may be associated with it.

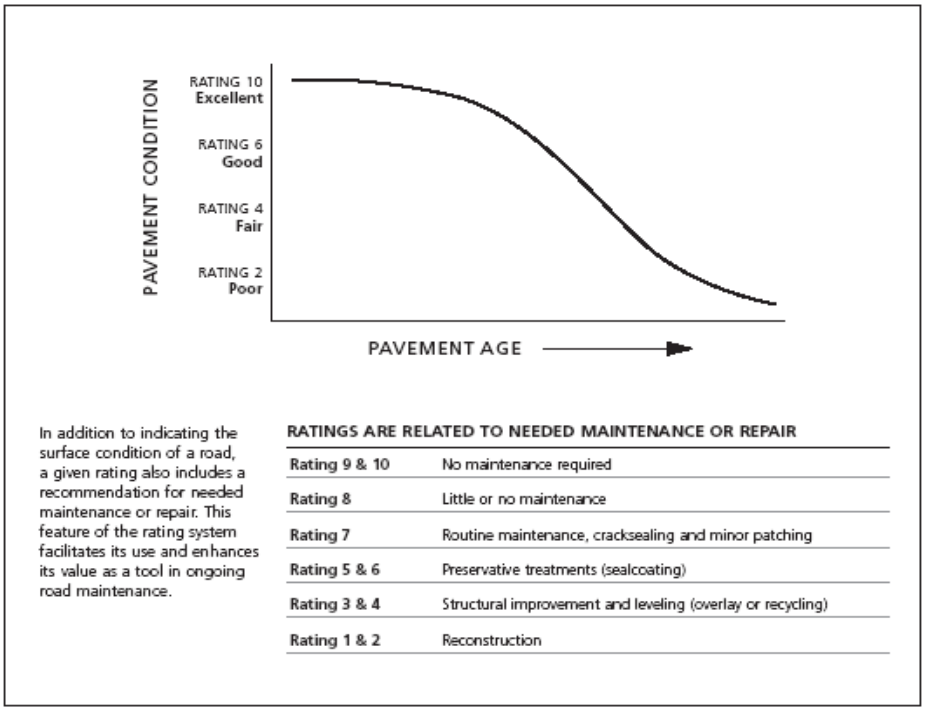


Figure 5-1: Pavement condition vs. pavement type curve and ratings

PASER HMA Rating System

The following table uses PASER ratings (as described in Chapter 4) to categorize HMA pavements and recommend possible fix alternatives.

Table 5-4: PASER HMA Rating System

PASER HMA Rating system		
10 Excellent	None	New construction.
9 Excellent	None	Recent overlay. Like new.
8 Very Good	No longitudinal cracks except reflection of paving joints. Occasional transverse cracks, widely spaced (40' or greater). All cracks sealed or tight (open less than ¼").	Recent seal coat or new cold mix. Little or no maintenance required.
7 Good	Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks (open ¼") due to reflection or paving joints. Transverse cracks (open ¼") spaced 10' or more apart, little or slight crack raveling. No patching or very few patches in excellent condition.	First signs of aging. Maintain with routine crack filling.
6 Good	Slight raveling (loss of fines) and traffic wear. Longitudinal cracks (open ¼"- ½"), some spaced less than 10'. First sign of block cracking. Sight to moderate flushing or polishing. Occasional patching in good condition.	Shows signs of aging. Sound structural condition. Could extend life with sealcoat.
5 Fair	Moderate to severe raveling (loss of fine and coarse aggregate). Longitudinal and transverse cracks (open ½") show first signs of slight raveling and secondary cracks. First signs of longitudinal cracks near pavement edge. Block cracking up to 50% of surface. Extensive to severe flushing or polishing. Some patching or edge wedging in good condition.	Surface aging. Sound structural condition. Needs sealcoat or thin non-structural overlay (less than 2").
4 Fair	Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (½" deep or less).	Significant aging and first signs of need for strengthening. Would benefit from a structural overlay (2" or more).
3 Poor	Closely spaced longitudinal and transverse cracks often showing raveling and crack erosion. Severe block cracking. Some alligator cracking (less than 25% of surface). Patches in fair to poor condition. Moderate rutting or distortion (1" or 2" deep). Occasional potholes.	Needs patching and repair prior to major overlay. Milling and removal of deterioration extends the life of overlay.
2 Very Poor	Alligator cracking (over 25% of surface). Severe distortions (over 2" deep) Extensive patching in poor condition. Potholes.	Severe deterioration. Needs reconstruction with extensive base repair. Pulverization of old pavement is effective.
1 Failed	Severe distress with extensive loss of surface integrity.	Failed. Needs total reconstruction.

** Individual pavements will not have all of the types of distress listed for any particular rating. They may have only one or two types.*

PASER Concrete Pavement Rating System

The following table uses PASER ratings (as described in Chapter 4) to categorize concrete pavements and recommend possible fix alternatives.

Table 5-5: PASER Concrete Pavement Rating System

PASER Concrete Pavement Rating system		
10 Excellent	None	New pavement. No maintenance required.
9 Excellent	Traffic wear in the wheel path. Slight map cracking or pop-outs.	Recent concrete overlay or joint rehabilitation. Like new condition. No maintenance required.
8 Very Good	Pop-outs, map cracking, or minor surface defects. Slight surface scaling. Partial loss of joint sealant. Isolated meander cracks, tight or well sealed. Isolated cracks at manholes, tight or well sealed.	More surface wear or slight defects. Little or no maintenance required.
7 Good	More extensive surface scaling. Some open joints. Isolated transverse or longitudinal cracks, tight or well sealed. Some manhole displacement and cracking. First utility patch, in good condition. First noticeable settlement or heave area.	First sign of transverse cracks (all tight); first utility patch. More extensive surface scaling. Seal open joints and other routine maintenance.
6 Good	Moderate scaling in several locations. A few isolated surface spalls. Shallow reinforcement causing cracks. Several corner cracks, tight or well sealed. Open (¼" wide) longitudinal or transverse joints and more frequent transverse cracks (some open ¼").	First signs of shallow reinforcement or corner cracking. Needs general joint and crack sealing. Scaled areas could be overlaid.
5 Fair	Moderate to severe polishing or scaling over 25% of the surface. High reinforcing steel causing surface spalling. Some joints and cracks have begun spalling. First signs of joint or crack faulting (¼"). Multiple corner cracks with broken pieces. Moderate settlement or frost heave areas. Patching showing distress.	First signs of joint or crack spalling or faulting. Grind to repair surface defects. Some partial depth patching or joint repairs needed.
4 Fair	Severe polishing, scaling, map cracking, or spalling over 50% of the area. Joints and cracks show moderate to severe spalling. Pumping and faulting of joints (½") with fair ride. Several slabs have multiple transverse or meander cracks with moderate spalling. Spalled area broken into several pieces. Corner cracks with missing pieces or patches. Pavement blowups.	Needs some full depth repairs, grinding, and/or asphalt overlay to correct surface defects.
3 Poor	Most joints and cracks are open, with multiple parallel cracks, severe spalling, or faulting. D-cracking is evident. Severe faulting (1") giving poor ride. Extensive patching in fair to poor condition. Many transverse and meander cracks, open and severely spalled.	Needs extensive full depth patching plus some full slab replacement.
2 Very Poor	Extensive slab cracking, severely spalled and patched. Joints failed. Patching in very poor condition. Severe and extensive settlements or frost heaves.	Recycle and/or rebuild pavement.
1 Failed	Restricted speed. Extensive potholes. Almost total loss of pavement integrity.	Total reconstruction.

Road CPM Treatment Options & Condition Criteria

Refer to Appendix A-4 and A-5 for guidelines for CPM fixes based on pavement type, Distress Index (DI), Ride Quality Index (RQI), International Roughness Index (IRI) and rutting.

Capital Preventive Maintenance Program (Safety Criteria)

Safety history and road measurements needed for HMA resurfacing projects

Projects that have been selected for CPM funding do not require a crash history analysis, except for HMA resurfacing projects. On those projects, the regions will be required to accurately report superelevation measurements for curves that have a history of crashes. A correlation of crashes to deficient geometry may require a modification of superelevation.

Shoulder and guardrail specifications

The following criteria apply, to <u>all CPM projects:</u>

- A gravel shoulder shall require paved shoulder ribbons that are at least three feet wide.
- The regions are to conduct roadside hardware inspections to determine the amount of guardrail that has severe post and guardrail deterioration. The region will determine whether the guardrail should be upgraded on the capital preventive maintenance project or delayed until a future project. Replacement of deficient guardrail on freeways should be coordinated through the Region Development Engineer and the Lansing Traffic and Safety Division.
- Cable-Type guardrail (not Cable Median Barrier) shall be upgraded to current standards or appropriate slope modifications.
- Blunt and turned down guardrail endings shall be replaced with an appropriate ending from the Road and Bridge Standard Plans.
- Guardrails shall be connected to bridge rails and piers.
- The pavement markings, advance warning signs and crossbucks for all railroad crossings shall be upgraded to meet current standards. However, railroad crossbucks with active signals or gates do not require upgrading by the capital preventive maintenance program. The railroad company is responsible for replacing signals and gates with prioritization independent of the roadway projects.

Current CPM Fix Life Extensions

In each year's Integrated Call For Projects (CFP) Letter of Instructions a CPM Fix Life Extension table is provided for use in that year's CFP. Below is an example of this table (FY 2007). Refer to the current version of the CPM Manual and the instructions of the current CFP Letter, for the up to date information.

Fix Type	Life extension (in years)	Life extension (in years)	Life extension (in years)
	Flexible	Composite	Rigid
HMA Crack Treatment***	1-3	1-3	N/A
Overband Crack Filling***	1-2	1-2	N/A
One Course HMA Overlay	5-10	4-9	N/A
Mill and One Course HMA Overlay	5-10	4-9	N/A
Single Course Chip Seal	3-6	N/A	N/A
Double Chip Seal	4-7	3-6	N/A
Single Course Micro-Surface	3-5	**	N/A
Multiple Course Micro-Surface	4-6	**	N/A
Ultra-Thin HMA Overlay	3-6	3-6	N/A
Paver Placed Surface Seal	4-6	**	N/A
Full Depth Concrete Repair	N/A	N/A	3-10
Concrete Joint Resealing****	N/A	N/A	1-3
Concrete Spall Repair	N/A	N/A	1-3
Concrete Crack Sealing****	N/A	N/A	1-3
Diamond Grinding	N/A	N/A	3-5
Dowel Bar Retrofit	N/A	N/A	2-3
Concrete Pavement Restoration	N/A	N/A	5-10

2009 (FY 2007) Call For Projects CPM Fix Life Extensions*

*The time range is the expected life extending benefit given to the pavement, not the anticipated longevity of the treatment.
** A life extension will be provided, however, data is not available to quantify the life extension.
*** The life extension values for crack treatments on HMA surfaces should not be added to the values in the R&R Fix Life Chart when determining fix lives for entry into RQFS and MPINS. The life extension values for actual crack sealing jobs should still be programmed in MPINS but should not be included in RQFS.
**** The life extension values for concrete joint resealing and concrete crack sealing should **not** be added to the values in the R&R fix life chart when determining fix lives for entry into RQFS and MPINS. If the fix is applied in reaction to a poor performing pavement and the intent of the job is to get the original life expected out of the pavement, the fix should not be included in RQFS and the life extension value in MPINS should be limited to avoid overestimating the life of the pavement. Otherwise, the life extension value should be programmed in MPINS and included in RQFS.

Signs of Bridge Distress

Bridges are inspected at a maximum interval of 2 years and when they are in poor condition or structurally deficient, the inspection frequency is more often. A Bridge Inspection Report (BIR) is comprised of several reports, as discussed in chapter 4.

Bridge Safety Inspection Report

The Bridge Safety Inspection Report (BSIR) includes the National Bridge Inventory's 0 to 9 (NBI) bridge rating scale and major structural condition ratings for the deck, superstructure and substructure, along with over 20 Michigan specific condition ratings. The inspector comments, that accompany each NBI condition ratings, are important information that should be used for identifying bridge distress.

Pontis Bridge Inspection Report

The Pontis Bridge Inspection report provides element level condition ratings for distinct components (or elements) of a bridge. The Pontis element will be a certain type of material, such as concrete, steel or timber. In addition, it will have a quantity associated with it, such as lineal feet of beam. Pontis condition ratings can have quantities of the element in different condition states, thus the Pontis condition rating is more descriptive than the overall NBI condition rating. The Pontis Bridge Inspection Manual demonstrates how to examine various bridge elements and rate them based on the current condition (see Chapter 4 for additional information). Additionally, this manual provides some guidelines for recommended fixes based on the Pontis condition rating system. The Pontis Bridge Inspection Manual may be found on the MDOT website at:

Pontis Bridge Inspection Manual

http://www.michigan.gov/mdot/0,1607,7-151-9625_24768_24773---,00.html

A Commonly Recognized or CoRe element is a component of a bridge made of a singular material, in normal service, can be expected to deteriorate in a very similar fashion and at the same rate. It can also be inventoried (quantitatively) with units that are easily assessed by the field inspector and that have meaningful interpretation at the network level.

A Smart Flag is used to identify local problems that may not be reflected in the CoRe element condition state language, or a specific type of distress that the agency would like to track. A smart flag is treated like an element in order to record the quantity or percentage of the distress feature and to track deterioration rates. Smart flags allow MDOT to track distress conditions in elements that do not follow the same deterioration or do not have the same units of measure as the distress described in the CoRe element.

Referencing the MDOT Pontis Bridge Inspection Manual is recommended for condition state language, for all elements. The following pages illustrate example bridge elements in various conditions and provide guidelines for repair options.

Deck Spalling

Description
Deck Spalling is a condition where there is delamination of the bridge deck and concrete spalls on the top surface of bare concrete bridge decks, or bridge decks having rigid overlays.

Severity Levels (according to the 2007 Pontis Bridge Inspection Manual)

Condition State 1 Deck surface area is in good condition.

Condition State 2 Deck surface area has delaminations, however are not visible. Delaminated areas may not be seen. The delaminated area is measured by sounding the bridge deck. The perimeter of the delaminated area is often marked with spray chalk paint and photographed for future repairs and inspections. Deck delamination will often indicate locations where there is potential of future spalling.

NOTE: In most delaminated concrete slab surfaces, the top 1/8 to ¼ inch is densified and separated from the base slab by a thin layer of water or air

Possible Fix Options:
- No Action Required

Condition State 3 Deck surface area has spalled, and concrete or HMA patches in poor condition.

Possible Fix Options:
- Deck Patching *

* Patch the deck when 90% plus portion of the other areas of the deck are in good condition to maintain ride quality, until a more extensive repair can be done.

Deck Fascia

Description

The deck fascia is the vertical surface of the bridge deck that can be seen from the side of the bridge. It is just below the bridge barrier, but it is not part of the barrier. This smart flag is only triggered when there is noticeable deficiency to the deck's fascia.

Severity Levels (according to the 2007 Pontis Bridge Inspection Manual)

Condition State 1 **Fair Condition** - Minor cracking or spalling of the fascia is observed but there is no effect on the strength of the railing and there is no danger of large spalls dropping off the bridge.

Possible Fix Options:
- No Action Required

Condition State 2 **Poor Condition** - The fascia has significant cracking and/or spalling. The deteriorating fascia has potential for compromising the strength of the railing and/or dropping large spalls off the bridge.

Possible Fix Options:
-Sound Fascia and Remove All Loose Concrete

Condition State 3 **Serious Condition** - Deterioration of the fascia is serious and the strength of the railing system has been reduced and/or there is serious danger of large spalls dropping off the bridge.

Possible Fix Options:
- Sound Fascia and Remove All Loose Concrete
- Rehab Element

Unpainted Pin & Hanger Assembly

Description

The pin and hanger element is rated by the condition of link plates (hangers) and pin assemblies. There are separate elements for painted and unpainted pin and hangers. The quantity is each assembly.

Severity Level (according to the 2007 Pontis Bridge Inspection Manual)

Condition State 1 **Good Condition** - There is little or no corrosion of the unpainted steel. Weathering steel is coated uniformly and remains in excellent condition. Oxide film is tightly adhered.

Possible Fix Options:
- No Action Required

Condition State 2 **Fair Condition** - Surface rust, surface pitting, has formed or is forming on the unpainted steel. Weathering steel has not corroded beyond design limits.

Possible Fix Options:
- No Action Required

Condition State 3 **Poor Condition** - Steel has measurable section loss due to corrosion but does not warrant structural analysis.

Possible Fix Options:
- Clean and Paint

Condition State 4 **Serious Condition** - Corrosion is advanced. Oxide film has a laminar texture with thin sheets of rust. Section loss may be sufficient to warrant structural analysis to ascertain the impact on the ultimate strength and/or serviceability of either the superstructure or the portion over this beam area.

Possible Fix Options:
- Replace all Pin and Hanger Assemblies on Structure

Reinforced Concrete Bridge Railing

Description

Reinforced concrete bridge railing element, include all types and shapes of reinforced concrete bridge railing. All elements of the railing must be concrete. Concrete barriers with decorative metal rails are included here. Example in use: Open concrete parapet with metal rail or solid concrete parapet rail.

Severity Level (according to the 2007 Pontis Bridge Inspection Manual)

Condition State 1 **Good Condition** - The element shows little or no deterioration. There may be discoloration, efflorescence and/or superficial cracking but without effect on strength and/or serviceability.

Possible Fix Options:
- No Action Required

Condition State 2 **Fair Condition** - Minor cracks, surface scaling or spalls may be present but there is no exposed reinforcing or surface evidence of rebar corrosion.

Possible Fix Options:
- Patch Concrete Seal Cracks

Condition State 3 **Poor Condition** - Some delaminations and/or spalls may be present and some reinforcing may be exposed. Corrosion of rebar may be present but loss of section incidental and does not significantly affect the strength and/or serviceability of the element.

Possible Fix Options:
- Clean Rebar and Patch/Repair Concrete

Condition State 4 **Serious Condition** - Advanced deterioration. Corrosion of reinforcement and/or loss of concrete section may be sufficient to warrant analysis to ascertain the impact on the strength and/or serviceability of the element.

Possible Fix Options:
-Replace or Repair Rebar and Patch/Repair Concrete

Bridge Deck Preservation Matrixes User Guidelines

Bridge Deck Preservation Matrixes

The Bridge Deck Preservation Matrixes are tools that were developed to guide bridge scopers in determining the appropriate fix for a bridge deck given specific characteristics and ratings. One matrix is for bridge decks with uncoated "black" rebar and the other is for bridge decks with epoxy coated rebar (ECR). Primarily, the type of fix best suited for a bridge deck is determined by the percent of deficiencies of the top surface and bottom surface of the deck. Simply, if the bottom surface of the deck is in good condition, then the deck may be a candidate for top surface treatments, such as deck patching, epoxy overlays or rigid overlays. However, if the bottom surface of the deck has large percentages of deficiencies, then a deck replacement project may be more suitable. The Bridge Deck Preservation Matrixes are located in Appendix A-6. As this document is periodically updated, it is best to ensure the most current version is being used by looking for the Bridge Deck Preservation Matrixes at the following website:
http://www.michigan.gov/mdot/0,1607,7-151-9625_24768_24773---,00.html

Why you cannot rely solely on the Bridge Deck Preservation Matrixes to determine rehabilitation needs

The condition of the deck is usually the driving force, or the key indicator, leading to a structure being considered for rehabilitation or replacement. However, there are times when other issues affecting the bridge may elicit the need for a rehabilitation project and the Bridge Deck Preservation Matrixes do not address those situations. Examples of such situations are super-structure deterioration, substructure deterioration, and functional issues such as under-clearance and/or bridge width. The Bridge Deck Preservation Matrixes also do not address some functional issues, including roadway stopping sight distance (SDD), approach widths, design/posted speeds, interchange geometrics and etc. So the scoper is cautioned to interpret the information from the matrixes in the context of each specific case and use engineering judgment.

When the Bridge Deck Preservation Matrixes are used in conjunction with the Bridge Safety Inspection Report (BSIR), Pontis CoRe Element Data, inspector recommendations and Detailed Bridge Project Scoping Report, the matrixes can be an accurate guide in the majority of situations and will lead to a repair option that is economical and consistent with the Department's goals.

Bridge Preservation Guidelines

The preservation of bridges is important. To develop a fix strategy, the condition of the structures (and network) must be analyzed. It is important to review expansion joints to insure that the ADA plate covers are installed, a requirement of ADA compliance (the ADA plate covers were not installed for various reasons over the past few years

and will need to be addressed). The basic types of projects and the condition to be addressed are as follows:

Type of Project	Condition to be Addressed
Replacement and Rehabilitation	Poor structures
Capital Preventive Maintenance/ Capital Scheduled Maintenance	NBI 5- or 6-rated structures (joint replacements, deck patching, and substructure repair)
Shelf projects	NBI 5- or 6-rated structures (groups of P/H replacements, zone painting, joint replacements, deck patching and substructure repair)
Maintenance	Joint replacement, deck patch, scaling and substructure repair

The preservation of bridges is one of the Department's primary goals, and specific performance measures have been developed to meet these goals. Through the Call For Projects process, more specific objectives are developed and each Region develops a fix strategy and projects are selected in accordance with the statewide objectives and goals. MDOT divides bridge projects into three types of capital projects; replacement projects, rehabilitation projects and preventive maintenance projects. MDOT also uses state and county maintenance crews to do routine bridge maintenance. The following describes each of these project types and shows how the project type fits into MDOT's "Mix of Fixes" strategy.

- Replacement Projects - Addresses poor structures where the most economical long term fix is to replace the bridge or one of the major elements. Replacement projects include deck replacement, superstructure replacement and entire bridge replacement.
- Rehabilitation Projects – Addresses the needs of bridges having poor elements that require extensive work in order to improve their condition to good or fair ratings. Rehabilitation projects include rigid overlays of bridge decks, extensive superstructure repairs and substructure repairs.
- Capital Preventive Maintenance (CPM)/Capital Scheduled Maintenance (CSM) Projects - Addressing good and fair structures in order to slow the deterioration rate and keep them from dropping into the poor category for as long as possible. CSM projects include work types, such as superstructure washing, expansion joint repairs or drainage system cleaning that can be done on good or fair bridges. CPM projects are typically done on fair bridges (NBI 5 or 6 rated Structures) and the work types tend to be more extensive, such as expansion joint replacements, pin and hanger replacements, structural steel painting or deck patching.
- Routine Maintenance Projects – Addresses good or fair rated structures. This work, which preventive maintenance activities such as joint replacements, deck patching, scaling and substructure repair, is done by either MDOT Maintenance

Crews or contracted to County Maintenance Crews. It is an important component of MDOT's bridge preservation strategy.

Bridge Preservation Rules

The importance and examples of using preservation rules in context with other conditions

These rules are listed as stand alone rules. However, when more than one need is identified on a bridge, most often one fix is related to another and the interrelationship between the elements must be considered. For example, when replacing pin and hangers, the expansion joints will be also replaced at the same time.

Average Daily Traffic (ADT) and corridor issues should be considered. For example, even if a bridge expansion joint is leaking 20 percent of the length and the rule states replace when 40 percent is leaking, if work is being done in the corridor, we should take advantage of the traffic control and reduce user impact by replacing the joint along with the corridor work.

Deck

As much as possible these preservation rules coincide with the Bridge Deck Preservation Matrixes and they should be used in conjunction with the Matrix.

You will need to know NBI (National Bridge Inventory) surface condition ratings as well as Pontis ratings.

Concrete Crack Sealing

Concrete crack sealing should be considered when:

- The concrete is in good or fair condition, but has cracks that likely reach the depth of the steel reinforcement. Note – concrete must be more than 28 days old before it can be sealed.
- The cracks are greater than 0.010 inch wide.
- Crack can be seen from a standing position.
- The Pontis smart flag for deck cracking has been triggered and the condition state is 2, 3 or 4.
- The NBI rating for the deck surface is 5, 6 or 7 and 2 to 5 percent of the deck surface has deficiencies.
- Unsealed cracks exist which are narrow and/or are less than an 1/8 inch wide and are spaced more than 8 feet apart.
- When the bridge inspector has provided the size and frequency of the cracks on a good and fair deck surfaces warrant sealing, based on Work Recommendation.

Deck Patching

Deck patching should be considered when:

- Deck surface spalls or delaminations are between 2 and 5 percent of the deck surface has spalls or delaminations. A smaller percentage may need to be patched dependent also depending upon the severity of the defect.
- The NBI rating for Deck Surface is 5, 6 or 7. Comments should indicate between and 2 and to 5 percent of the deck surface has spalls.
- When the Pontis smart flag, for deck spalling (bare concrete

surface), shows 2 to 5 percent of the deck in condition state 3 or when the Pontis smart flag for deck spalling (with protective surface) shows 2 to 5 percent of the deck surface rated 4.

- The bridge inspector has provided a Work Recommendation indicates a need for deck patching.

Epoxy Overlays Epoxy overlays or flood coats should be considered when:

- Between 2 and 5 percent of the deck surface has deficiencies or is in fair condition.
- Deck surface is rated good to fair condition with the NBI rating for Deck Surface is rated 5, 6 or 7 with only small areas of delamination or spalls and the deck surface has moderate to extensive cracking. Repair of the delaminated areas and spalls should be done before the overlay is performed.
- The deck surface has moderate to extensive cracking with multiple thin cracks but minimal delaminations or spalls.
- The entire deck should be sealed after deck patching.
- The surface of the existing epoxy overlay is in poor condition and a repeat epoxy overlay is needed.
- Note: for epoxy overlays and overlapping staged construction areas are a challenge in high ADT areas with tight lane widths. Repeat epoxy overlay when surface condition of existing epoxy overlay is in poor condition. The Pontis smart flag for deck spalling (with protective surface) can be used to identify epoxy overlay repair needs (quantity of condition state 2).

HMA Overlay with Waterproofing Membrane HMA overlay with waterproofing membrane should be considered when:

- Deck surface deficiencies are between 15 and 30 percent of the deck surface has deficiencies and between 15 and 30 percent of the deck bottom has deficiencies.
- A HMA overlay may be maintained, with a waterproofing membrane. This can be used as an alternative to epoxy overlays or rigid overlays.
- The NBI Surface rating is 5 (fair) or less.
- When full depth pre-cast deck panels are used.
- If the bridge is poor and will be replaced in the near future and the most cost effective fix is HMA overlay.

HMA Overlay with No Membrane HMA cap with no membrane should be considered when:

- Deck surface deficiencies greater more than 30 percent of the deck surface and the deck underside has greater than 30 percentage deficiencies. This is usually recommended only with a road project in the area, primarily on structures with existing HMA overlay, as surface conditions usually match approach conditions. A possible exception to this would be multiple bridges needing resurfacing.
- NBI Surface rating = NBI of the deck is 3 (serious).
- NBI surface rating of the Deck bottom surface rating = NBI is 3 (serious).
- Bridge is in 5-year plan for major rehabilitation, and ride quality improvement is an immediate need. This is used as a last resort to hold over a high ADT location until replacement

is possible.

Note: All HMA caps should have membranes unless the bridge is programmed for replacement.

Concrete Overlay - Shallow A shallow Concrete overlay – shallow should be considered when:

- Deck Surface has deficiencies of more than 15 percent.
- Deck underside has deficiencies of 5 to 30 percent.
- NBI Surface Rating of the Deck is 5 (fair) or less.
- NBI Surface Rating of the Deck bottom surface is 5 (fair) or 4 (poor).
- When the bridge inspector has provided a Work Recommendation of a rigid 'overlay' is flagged (see comments and deck ratings to determine type of overlay).

Concrete Overlay - A Deep Concrete Overlay – deep should be considered when:

- Deck surface has more than 15 percent of the deck surface with deficiencies.
- Deck underside has up to 10 percent of the deck underside with deficiencies.
- Surface rating is less than or equal to NBI 5.
- Deck bottom surface rating is NBI 5 (fair) or NBI 6 (fair).
- When the bridge inspector has provided a work recommendations for rigid 'overlay' (see comments and deck ratings to determine what type of overlay).

Note: Some decks with poor bottom surfaces can be deep overlaid if joint or railing replacement removes the majority of the deficiencies.

Barrier Patching Barrier patching should be considered when less than 10 percent of the barrier is spalled.

- The barrier is spalled less than 30%.
- When the Pontis condition rating is 2 or 3.

Barrier Replacement Barrier replacement should be considered when:

- Deck rating is rated in good or fair condition, and the barrier is in poor condition, with more than 30 percent of its surface having spalls or other deficiencies.
- Sidewalk or brush block width is more than 2½ feet wide and an overlay is planned (a retrofit per, Standard B-23, can be done for a sidewalk or brush block less than 2½ feet wide).
- When the Pontis condition rating is rated 4.
- Safety upgrade is needed.

Deck Replacement Deck replacement should be considered when:

- Deck bottom surface has more than 25 percent of the deck bottom surface with deficiencies.
- Deck surface NBI rating of the deck surface and deck bottom is 4 (poor) or less.
- All the deck rehabilitation needs will cost so much that deck replacement cost is competitive in comparison.
- Slag Aggregate is identified in the existing deck and the bridge meets the criteria for deep concrete overlay.

Deck Joints

Always replace joints when doing deep or shallow overlay.

Strip Seal Joint Repair

Repair of Seal Joints should be considered when:

- Leaking Joints.
- NBI rating of the Expansion Joint is 5 (fair).
- Pontis rating of the Strip Seal Expansion Joint is rated 2.
- Work Recommendation for 'joint repair' is flagged.

Strip Seal Joint Replacement

Replacement of strip seal joints should be considered when the joint is leaking and:

- The Rail is damaged so that the joint can not be sealed.
- More than 40 percent of adjacent concrete is damaged.
- NBI rating of the Expansion joint is rated 4 (poor) or less.
- Pontis rating of the Strip Seal Expansion Joint (Pontis Element 400) is rated 3.
- Pin & Hangers are being replaced and can not cannot be supported from below (this applies to any expansion joint with pin & hanger).

Pourable Joint Seal Repair

Repair of ~~P~~ourable ~~J~~oint ~~S~~eals should be considered when:

- Leaking joints.
- NBI rating of the ~~E~~xpansion ~~J~~oint is rated 5 (fair).
- Pontis rating of the ~~P~~ourable ~~J~~oint ~~S~~eal (Pontis element 401) is rated 2.
- Work Recommendation for 'Joint Repair is flagged.

Note: Pourable joint seals should be set up for routine reseals, perhaps on a biannual basis.

Pourable Joint Seal Replacement

Replacement of Pourable Joint Seals should be considered when the joint is leaking and:

- More than 30 percent of the adjacent concrete is damaged.
- NBI rating of the expansion joint is rated 4 (poor) or less.
- Pontis rating of the Pourable Joint Seal (Pontis Element – Pourable Joint Seal 401) is rated 3.
- Work Recommendations – Joint Repair comments.
- Pin & Hangers are being replaced and cannot be supported from below (this applies to any expansion joint with Pin & Hanger).

Compression Joint Seal Repair

Repair of Compression Joint Seal should **not** be considered.

- Do not repair. If leaking replace.

Compression Joint Seal Replacement

Replacement of Compression Joint Seals should be considered when:

- Joint is leaking.
- NBI rating of the Compression Expansion Joint rating is 4 or less.
- Pontis rating of the Compression Joint Seal is (Element Compression Joint Seal 402) is rated 2 or 3.
- Work Recommendation for 'joint replacement' is flagged.
- Pin & Hangers are being replaced and cannot be supported from below (this applies to any expansion joint with pin & hanger).

Assembly Joint Seal (Modular) Repair

Repair of the Assembly Joint Seals (Modular) repair should **not** be considered.

- Do not repair if leaking. Should replace joint.

Assembly Joint Seal (Modular) Replacement

Replacement of Assembly Joint Seals (Modular) should be considered when:

- Joint is leaking.
- NBI rating of the expansion joint seal is 4 or less.
- Pontis rating of the expansion joint is 3.
- Work Recommendation for 'joint replacement' is flagged.
- Pin & Hangers are being replaced and cannot be supported from below (this applies to any expansion joint with pin & hanger).

Steel Armor Expansion Joints (open) Repair

Repair of Steel Armor Expansion Joints should **not** be considered, if they are leaking. Some of these joints were sealed when installed, but the seal does not last.

- Do not repair. If leaking the joint should be replace.

Steel Armor Expansion Joints (open) Replacement

Replacement of Steel Armor Expansion Joints should be considered when:

- Joint is leaking.
- NBI rating of the Expansion Joint is 4 or less.
- Pontis rating of the expansion joint is rated 3.
- Work Recommendation for 'joint replacement' is flagged.
- Pin & Hangers are being replaced and cannot be supported from below (this applies to any expansion joint with pin & hanger).

Polymer Block Out Expansion Joint Repair

Repair of Polymer Block Out Expansion Joints should be considered when:

- Joint is leaking.
- NBI rating of the Expansion Joint is 5.
- Pontis rating of the Expansion Joint is 3.
- Work Recommendation for 'joint repair' is flagged.

Polymer Block Out Expansion Joint Replacement

Replacement of Polymer Block Out Expansion Joints replacement should be considered when:

- 30 percent of the concrete or polymer is damaged.
- NBI rating of the Expansion Joint is 4 or less.
- Pontis rating of the Block Out Expansion Joint is 3.
- in a Work Recommendation for 'joint replacement' is flagged.
- Pin & Hangers are being replaced and cannot be supported from below (this applies to any expansion joint with pin & hanger).

Block Out Expansion Joint Replacement

Repair of Block Out Expansion Joints should **not** be considered.

- Do not repair. Joint should be replaced.

Block Out Expansion Joint Repair

Replacement of Block Out Expansion Joints should be considered when:

- Leaking joints.
- NBI rating of the expansion Joint is 4 or less.
- Pontis rating is rated 3.
- Work Recommendation for 'joint replacement' is flagged.
- Pin & Hangers are being replaced and cannot be supported from below (this applies to any expansion joint with pin & hanger).

Superstructure

Superstructure Washing

Superstructure Washing should be considered when:

- Salt contaminated dirt and debris has collected on the superstructure and is causing corrosion or deterioration by trapping moisture.
- Expansion or construction joints are to be replaced, and the steel is not to be painted.
- Prior to a detailed inspection.
- When the bridge inspector has provided a work recommendation for superstructure washing.
- Note: A superstructure washing can only be performed by in-house crews, not under contract.

Concrete Surface Washing

Concrete surface coating should be considered when:

- Surface of the concrete is exposed to salt contamination and it needs to maintain the appearance.
- The concrete has been patched and it needs to maintain the appearance.
- Widespread map cracking, possibly superficial, or there are vertical cracks and sealing may retard corrosion of reinforcement (barriers).
- Multiple thin cracks are forming.

Pin and Hanger Replacement

Pin & Hanger replacement should be considered when:

- The Pin & Hangers have excessive section loss, when there is pack rust between the hanger and the beam web and/or when there are signs of out-of-plane distortions.
- Pontis elements Pin & Hanger Assembly (Steel Unpainted) or Pin and Hanger Assembly (Steel Painted) are in rated 3 or 4.
- Pontis rating of a frozen or deformed pin & hanger assembly is rated 1, 2 or 3.
- The existing pins are not stainless steel and the assemblies do not have non-metallic washers.
- Consider when full or zone painting is being done.

Spot Painting Spot painting should be considered when:

- The existing paint is zinc based. Do **not** spot paint on lead based paint systems. If SIA Item 78 – Paint Type is 1, then it is lead based. Bridges painted before 1978 typically have lead based paint systems (unless they have already been repainted). SIA Item 202 – Year Painted can also be used to determine if structure has lead based paint.
- Less than 5 percent of paint area has failed paint, in isolated areas.
- Between 2 to 5 percent of a steel beam has a Pontis rating of condition state 3 or 4, while the remainder of beam is rated 1.
- When the bridge inspector has provided a work recommendation for spot or zone painting.

Zone Painting Zone painting should be considered when:

- Less than 15 percent of the existing paint area has failed, the remainder of paint system is in good or fair condition and the area of failed paint is grouped together (such as at beam ends).
- Pin & Hangers are being replaced.
- Beam end repairs are being made.
- NBI rating for paint condition is 5 (fair) or 4 (Poor) and having 3 to 15 percent paint failure.
- 3 to 15 percent of the steel painted elements have a Pontis rating of 3 (poor) or 4 (serious).
- Expansion or construction joints are to be replaced and full painting is not in the scope.
- When between 3 and 10 percent of unpainted A-588 steel beams area shows failure of the protective patina (flaking and weathering steel surface is dark brown or black) or steel is showing measurable section loss.

Complete Painting Complete painting should be considered when:

- Painted steel beams have greater than 15 percent of the existing paint area failing.
- Active corrosion evident on more than 20 percent of the steel beam area on the A-588 beams.
- BSIR Paint rating is 3 (serious) or worse.
- Pontis Steel Painted Elements have 15 percent or greater rated 3 or 4.
- When the bridge inspector has provided a work recommendation for complete painting.

Superstructure Repairs Superstructure repairs should be considered when:

- Steel beam ends should be repaired when there is more than 25 percent section loss in areas of the beam that affect load carry capacity.
- Prestressed Concrete, I-Beam Ends should be repaired when there is more than 5 percent spalling. (there is not a current repair option for repairing the beam ends on a side-by-side prestressed box beam).
- NBI condition rating for section loss is rated 1 (Note: the NBI section loss rating provided on the BSIR is on a 0 to 3 rating scale).
- When hit by high loads. When Pontis, Traffic Impact section is

rated 3 (impact damage has occurred and the strength of the member is impaired).

Superstructure Replacement

Superstructure replacement should be considered when:

- When more than 30 percent of the superstructure is in poor or serious condition.
- When the cost to rehabilitate the superstructure and deck exceeds the cost of replacement (either construction cost or life cycle cost).

Note: consider long-term maintenance when concrete beams are an option to replace steel having existing section loss.

Substructure

Concrete Sealing

Concrete sealing should be considered when:

- Top surface of the pier or abutments are below deck joints and when dirt contaminated with salt can collect on the surface.
- Surface of the concrete is exposed to heavy salt exposure. Horizontal surfaces of substructure elements are directly below expansion joints (i.e. independent backwalls, piers supporting simply supported spans and etc.).
- Consider if corridor work is being done and if the substructure condition is fair.

Concrete Surface Coating

Concrete surface coating should be considered when:

- Surface of the concrete is exposed to salt contamination and it needs to maintain appearance.
- The concrete has been patched and it needs to maintain appearance.
- Piers and abutments are in good or fair condition.
- Consider if corridor work is being done and if the substructure condition is fair.
- Thin cracks with high density are forming.

Substructure Concrete Patching and Repair

Substructure concrete patching and repair should be considered when:

- Less than 30 percent of the concrete substructure is spalled and delaminated.
- NBI rating for abutments or piers is 5 (fair) or 4 (poor) and comments indicate less than 30 percent of their surface has deficiencies.
- Pontis rating of the Column or Pile Extension, Pier Wall and/or Abutment Wall is rated 3 (poor) or condition state 4 (serious) and between 2 to 30 percent of their surface has deficiencies.
- Work recommendation for 'substructure patching' is flagged.

Scour Countermeasures

Scour countermeasures should be considered when (consult with the Hydraulic Section):

- Local scour holes are found.
- Structure is categorized as scour critical and there are no long term plans to replace the bridge.
- Pontis rating for Scour is rated 2. Scour exists at the structure site and if left unchecked could adversely impact the structural integrity of the bridge.

- NBI comments in the abutment and pier ratings indicate scour holes are present.
- Pontis rating for scour is 3 (scour is significant enough to warrant analysis of the structure).

Substructure Replacement or Partial Substructure Replacement

Substructure replacement or partial substructure replacement (such as pier cap) should be considered when:

- More than 30 percent of the area has spalling or other deficiencies. This rule must be considered carefully, because for some substructure types, very little surface area of the element is exposed.
- There are open vertical cracks and signs of differential settlement, especially if the settlement or substructure appears to be actively moving (scour may drive pier replacement when deck or superstructure replacement is needed).
- NBI rating for abutments or piers is 4 (poor), 3 (serious) or 2 (critical) and more than 30 percent of the area has deficiencies.
- more than 30 percent of the substructure has a Pontis rating of 3 (poor) or 4 (serious).

Miscellaneous

Vegetative Control

Vegetation control should be considered when:

- Brush, tree limbs or other vegetation grow against the structure keeping it moist for long periods of time. When grass and vegetation is growing from joints and cracks, such as within slope paving.
- Inspection recommendation and comments indicate "Brush Cut."

These items should have a duration attached to them. Depending on the location of the structure, these items should be done every year in some locations and every two years in others.

MDOT maintenance crews perform these activities and can not be done under contract.

Drainage System Cleaning

Drainage system cleaning / repair should be considered when:

- The drainage structures are full of debris. This may be evident by ponding on the bridge deck.
- The drainage structure or concrete adjacent to the drainage structure is damaged.
- Drainage structure comments on the BSIR may have comments that indicate the drainage system needs cleaning or repair.

Approach Pavement Relief Joints

Approach pavement relief joints should be considered when:

- There are indications that pavement growth of the adjacent roadway pavement is causing distress to the bridge. Signs of distress can be spalling of the bridge abutments beneath the beam bearings (when structure has dependent backwalls), when gaps between beam ends have closed (this can often be seen at pin and hangers.).
- Pontis beam end contact occurs. Note: Beam end contact can be the result of other causes.

- Pontis indicates a frozen or deformed pin & hanger assembly and is rated 3.

Slope Paving Repair Slope paving repair should be considered when:

- The slope paving has areas of distress or failure or when there is settlement beneath the slope paving.
- NBI rating for Slope Protection is 5 (fair) or below. Comments must be reviewed to determine where repairs are needed.

Note: This work is most often done with other work unless done by our forces or the problem is serious.

Structure Replacement Structure replacement should be considered when:

- When the cost to rehabilitate the structure exceeds the cost of replacement (either construction cost or life cycle cost).
- Removal of spans is an option.
- Existing superstructure and substructure are in serious condition with an NBI rating of 3 or less and substructure repairs are not feasible.
- When a substructure is scour critical and all scour retrofit options have been exhausted.
- Replacing the superstructure increases the load on substructure beyond capacity.
- Deck replacement or superstructure replacement requires changes to address functional issues (i.e. vertical clearance, width and etc.).

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