Montana Department of Transportation

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VISION ZERO
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zero serious injuries

MEMORANDUM

From:	Andy Cullison, P.E., Bridge Operations and Conditions Engineer
Approved By:	Amanda Jackson, P.E., Bridge Management Engineer
Date:	August 2017
Subject:	Jump Crack Awareness

Background

In June of 2016, severe cracking was noted on two relatively new bridge decks, Superior Area Structures –MP 49.397 EB (MDT ID#s: 01358, 01359) and Lozeau-Tarkio Structures –MP 57.472 (MDT ID#s 01367, 01368). The bridges had full deck replacements in 2010 and 2011, respectively. The cracking in both bridges led to full depth holes in the decks. These holes developed relatively rapidly with very little warning compared to typical deck failures that happen on older decks with traditional spalls and delamination's. Additional bridges and bridge decks, many of which are relatively early in their design life, were identified with the same widespread transverse cracking patterns that have the potential to deteriorate and rapidly develop similar deck holes. These decks are being treated with a deck seal to "heal" the cracks and a polymer overlay to cap and protect the surface of the decks.

In April of 2017, Wiss, Janney, Elstner Associates, Inc. (WJE) completed a report on their investigation into these bridge decks. The report can be found at Forensic-Deck-Analysis-Report-2017-04-21. The bridge decks that have been identified with the same transverse cracking patterns are 1 to 9 year old replacement decks over existing superstructures and on complete structure replacements of the same general vintage. The transverse cracks are appearing on both short-span and long-span structures, both steel and prestressed concrete, and includes deck thicknesses ranging from 6½ to 9 inches.

Transverse Cracking

Transverse cracking describes cracks in the bridge deck that are along the transverse dimension of the bridge and occur with regular and repetitive spacing. Generally, the spacing ranges from about 2 to 8 feet between cracks. Transverse cracks are commonly the result of the bridge deck concrete trying to shrink while it cures, dries, and when the temperature decreases. As the concrete shrinks, its length is trying to decrease but is held in place by the connection to the girder. The more the concrete shrinks the more stress builds in the concrete until eventually a weak point will form a crack to relieve the stress and allow the change in length.

Transverse cracks can develop in the first few days after construction and some develop much later after the bridge deck is exposed to traffic. Transverse cracks are typically the full depth of the bridge deck, and most commonly occur directly over transverse reinforcing steel.

Jump Cracks

A jump crack is a semi-longitudinal crack that "jumps" or connects two closely spaced transverse cracks. Jump cracks generally form when two transverse cracks are closely spaced, usually 6 to 24 inches. Jump cracks are usually the full depth of the deck, and may exhibit efflorescence. Jump cracks indicate an advanced stage of deterioration in the deck and are a sign that a hole may soon develop in the bridge deck.

Any delamination or spalling noted in the bridge decks will generally not be associated with the transverse cracking issues. Chaining will not give an indication as to an area that may be a problem, since the cracks are full depth and there is no traditional spalling associated with this issue.

The holes will develop in the areas where the jump cracks create "islands" of concrete. These problem areas occur where the pieces of concrete on either side of the cracks are "working" or moving against each other. This tends to create more cracks in the concrete island and even shears some of the reinforcement because of excessive movement around the cracks. Smaller chunks or "islands" of full depth concrete are then free to fall out, creating full depth deck holes.

One of the best indications of a problem area that is more advanced in its deterioration condition is a change in the efflorescence color on the soffit. If the cracks in and around and "island" of concrete are working and moving, there is usually evidence of excessive of leakage through the cracks and the efflorescence is a grayish color (from the grinding, which creates concrete powder) instead of the normal white in most of the other surrounding cracks.

Inspection

Inspect and document transverse cracks in the deck and any adjoining jump cracks in the concrete deck element transverse pattern cracking defect. Document the typical spacing between the transverse cracks, the typical widths of the transverse cracks, and check to see if the cracks are full depth. Note the size and locations of all jump crack areas and emphasize areas where heavy and/or grey efflorescence is present, especially if associated with heavy water staining and dense cracking or "islands".

A new defect called Concrete Deck, Transverse Pattern Cracking has been added to SMS. This new defect is attached to the cracking defect for concrete decks, meaning it is always used in conjunction with the concrete deck cracking defect (just like the damage defect must be used in conjunction with another defect). The deck cracking defect can be used without the transverse pattern deck cracking defect if cracking does not meet the criteria for transverse pattern cracking, but the transverse pattern cracking defect can never be used without the deck cracking defect.

As always, document conditions with photos. Use the descriptions in the table below to determine the condition state of the defect:

Defect	Concrete Deck, Transverse Pattern Cracking
Condition State	Description
1	No or only short, random “jump” cracks noted.
2	Beginning “jump” cracks. Cracks may be full depth. Minor efflorescence with no gray staining.
3	Narrow jump cracks with concrete islands likely. Most transverse cracks full depth. Efflorescence is present but little to no gray efflorescence.
4	Full depth transverse cracking. Full depth jump cracks, resulting in concrete islands. Possible raveling of closely spaced cracks, especially in “island” areas. Heavy gray colored efflorescence present. Water staining evident from leakage through cracks, especially in island areas. Future deck holes likely or holes repaired by Maintenance are present.

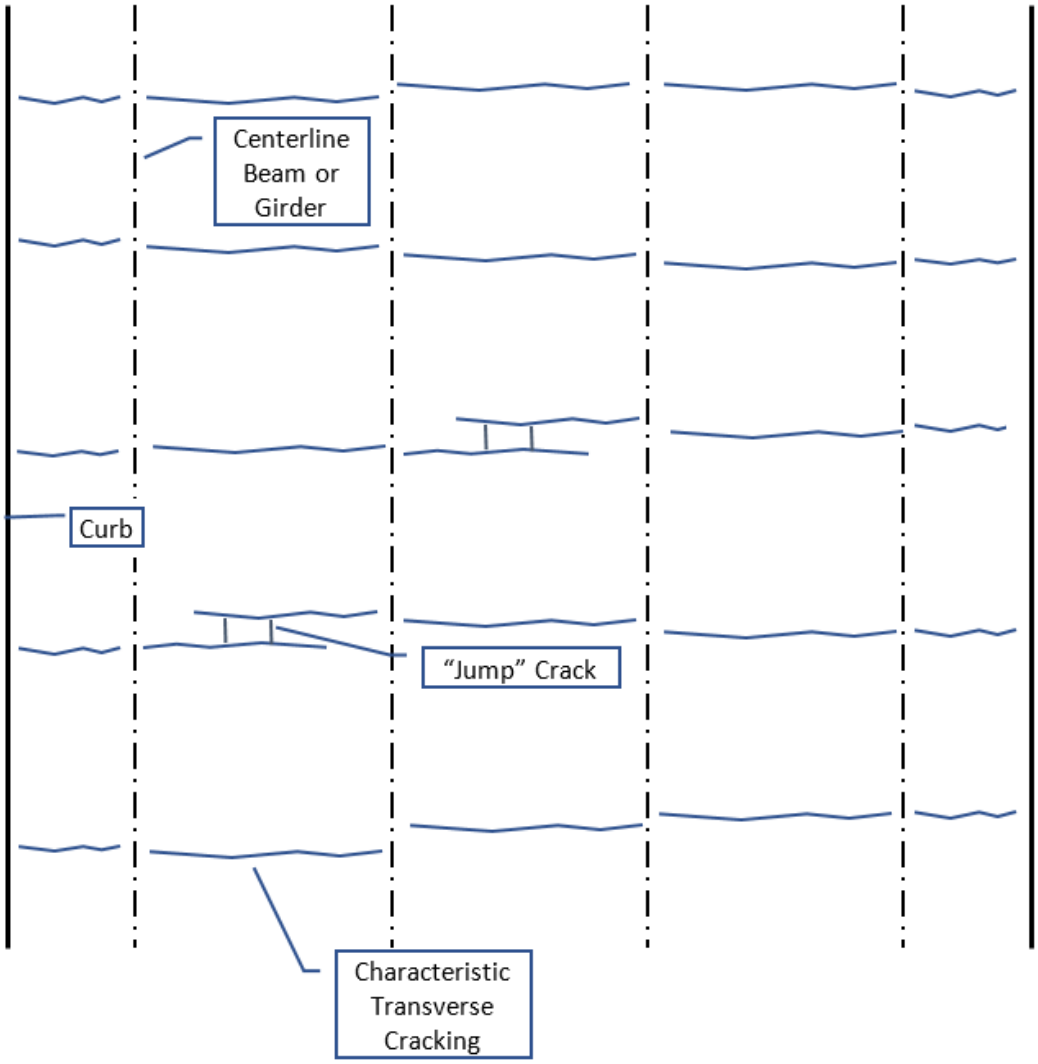


Figure 1. Sketch of Transverse and Jump Cracks



Figure 2. Transverse Cracks in Bridge Deck



Figure 3. Typical Transverse Cracks Seen From Underneath



Figure 4. Holes in Bridge Deck. Note the longitudinal jump cracks that create the rectangular “island” of concrete. The “island” continued to crack until full depth chunk or “island” fell out, creating the hole.



Figure 5. Same hole as Fig. 4 as seen from Underneath. Note the heavy staining on the soffit and girders from leakage in the cracks around the hole and in nearby transverse cracks. Note, little or no staining in cracks in adjacent girder bay. Note jump cracks with beginning staining at another location not far from the hole.



Figure 6. Example of Heavy staining from water leakage. Note the contrast between the gray efflorescence in the upper 2 transverse cracks (evidence of concrete movement around crack and heavy water leakage) and the white efflorescence in the bottom transverse cracks. Note the longitudinal jump crack with light white efflorescence.



Figure 7. When to not use the transverse pattern cracking defect. Use the deck cracking defect only. Transverse cracking is present but sporadic. Note the wide crack spacing, the lack of staining, and no longitudinal jump cracks. All efflorescence is white.



Figure 8. Example of Condition State 2. Note possible beginning jump cracks



Figure 9. Example of Condition State 3. Note the tight spacing (12” to 18”) of some of the transverse cracks, along with evidence of heavy leakage and some gray efflorescence. Also, small jump cracks evident.

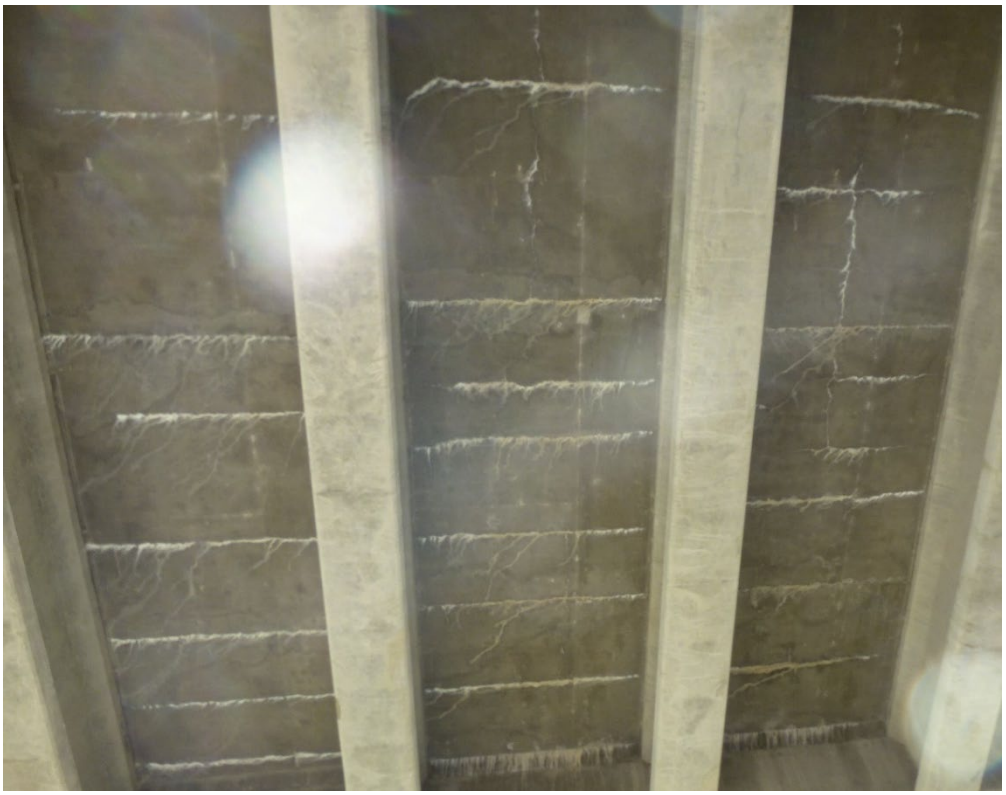


Figure 10. Example of Condition State 3. Tight spacing, jump cracks, some light staining from leakage, and some gray efflorescence.



Figure 11. Example of Condition State 4. Note the tight spacing, multiple jump cracks (some creating the concrete “islands”), very heavy gray staining and efflorescence.



Figure 12. Example of Condition State 4. Tight spacing, jump cracks, “islands”, grey colored efflorescence present, very heavy water staining, repaired hole.