

ACCESS METHODS, TEST EQUIPMENT & MAINTENANCE OF TRAFFIC

9/18/2020

NBI Calibration 2020

Access Methods, Test Equip. & Maint. of Traffic

Types of Access Equipment

- Under Bridge Inspection Trucks (UBIT)
- Platform Inspection Trucks
- Manlift (Scissor Lift and Boom Lifts)
- Bucket Truck
- Ladder
- Boat
- Technical Climbing

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Access Methods, Test Equip. & Maint. of Traffic

Under Bridge Inspection Trucks



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Access Methods, Test Equip. & Maint. of Traffic

Platform Inspection Trucks



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Manlift



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Bucket Truck



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Ladder



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Boat



Boats provide access for water-level inspections including soundings for scour measurements.

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Technical Climbing



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Access Methods, Test Equip. & Maint. of Traffic

Proper Safety Equipment

- Hard Hats
- Gloves
- Boots
- Safety Harness
- Protective Eyewear
- Filter Mask (Histoplasmosis)
- Air Meter (Confined Space Entry)
- Air Blowers (Confined Space Entry)
- Water Safety – flotation vest

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Access Methods, Test Equip. & Maint. of Traffic

IN-DEPTH PROCEDURE Inspections:

- Closer look at potential problem spots
- Difficult access may discourage close up inspection
- Visual access to bridge elements is needed at a minimum
- **Periodic use of equipment to verify element condition is recommended**



Examples

- Beam ends below joints
- Tall substructures
 - Bearings
 - Bridge Seats
 - Caps
- Members subjected to fatigue
- Cross frame connections

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Vaulted Abutment



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Avoid one-person inspections due to potential hazards

- Deep / Fast moving water
- Inspections near traffic
- Potential to fall
- Wild or Farm Animals
- Criminal Activity



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Access Methods, Test Equip. & Maint. of Traffic

Improve Visibility

- Bridge Washing
 - Improves visibility
 - Saves inspection time
 - Improves insp. quality
 - Preserves the bridge
- Lights & Mirrors
 - Flashlights
 - Floodlights
 - Mirrors



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Access Methods, Test Equip. & Maint. of Traffic

Projects Involving Railroads

- Special Agreements (Right of Entry, etc.) may be required
- Flagger
- Advance Notice and Scheduling
- Payment to Railroad may be required to meet some requirements

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Access Methods, Test Equip. & Maint. of Traffic

Private Property Considerations

- Avoid damage to private property
- Obtain permission to use / park on private property during inspection
- Carry identifying credentials
- Avoid excessive “Inspection Graffiti” on structural elements visible to the public and property owners
 - Crayon
 - Paint
 - Permanent Marker

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Access Methods, Test Equip. & Maint. of Traffic

Notifications

- Avoid perception of a “terrorist act” in progress
- Law enforcement notifications
- Coast Guard
- Railroad or other non-highway entities under/near bridge
- Public notification - Press Release prior to work

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Access Methods, Test Equip. & Maint. of Traffic

Test Equipment

- **Electronic Distance Measuring**
- **Smart Levels**
- **Ultrasonic Thickness Measuring**
- **Rotary Percussion**

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Access Methods, Test Equip. & Maint. of Traffic

Electronic Distance Measuring

- Allows quick measurement
- One person can operate
- Accurate
- Can be hard to see laser over long distances



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Access Methods, Test Equip. & Maint. of Traffic

Smart Levels

- Quick measurement of angles
- One person can operate
- Accurate
- Requires a relatively even surface



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Access Methods, Test Equip. & Maint. of Traffic

Ultrasonic Thickness Measuring

- Quick measurement of homogenous metal thickness
- Only need access to one side of steel
- Need a relatively clean and smooth surface to measure



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Access Methods, Test Equip. & Maint. of Traffic

Rotary Percussion

- Quick inspection of overhead & vertical surfaces
- Detects concrete delaminations
- Easy to use
- Reach limited to +/- 20'

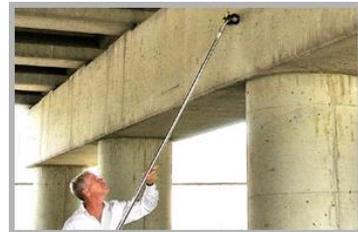


Photo Source: *Sounding technology*

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Access Methods, Test Equip. & Maint. of Traffic

Maintenance of Traffic

- Reference IDOT's 'Work Site Protection Manuals'
- Ensure safety of inspectors
- Ensure safety of traffic
- Minimize interference with traffic
- Minimize duration of closure
- Follow appropriate standard for roadway type
 - Expressway
 - Village street



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DISCUSSION

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REINFORCED CONCRETE SUPERSTRUCTURES

9/18/2020

NBI Calibration 2020

Item 59 – Concrete Superstructure

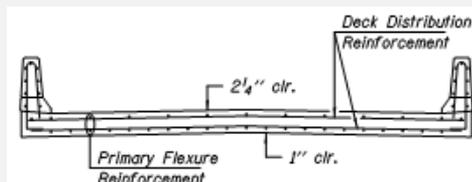
- **Common Types of Concrete Superstructures**
- **Deck Condition vs. Superstructure Condition**
- **Condition Ratings**

J-2

Item 59 – Concrete Superstructure

Cast in Place Conc. Slabs

- Common since early 1900's
- “Slab Superstructure” vs. “Deck”
 - Top of the slab superstructure serves as an integral deck
 - Slab superstructures span longitudinally vs. decks that usually span transversely
- Deck (Item 58) shall be rated same as Super (Item 59). The rating is based on the Super criteria



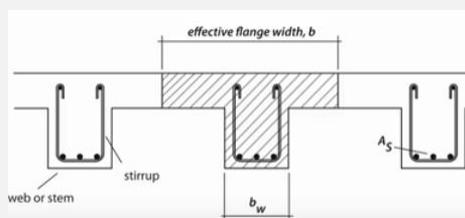
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Item 59 – Concrete Superstructure

Concrete T-Beams

- Common in 1930's - 50's
- Monolithic deck and stem forms the shape of a letter “T”
- Typically cast-in-place construction
- Top flange is considered the Deck (Item 58)
- Deck and stem act together as the superstructure (Item 59)



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Item 59 – Concrete Superstructure

Concrete Through Girders

- Common in 1940's, rarely used now
- Monolithic deck supported by a two-girder system
- Deck is cast between girders
- Upper portions of through girders serve as bridge railing
- Even though it is a two-girder system, girders are not FCMs



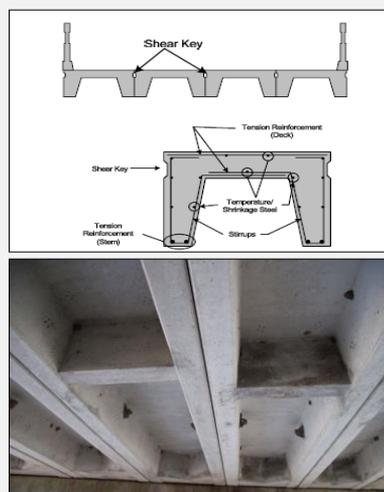
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Item 59 – Concrete Superstructure

Concrete Channel Beam

- Appearance of bridge cross section resembles T-Beam
- Usually made of precast concrete
- Typically not prestressed
- Top flange is considered the Deck (Item 58)
- Deck and stems act together as superstructure (item 59)
- Deck is integral with the Super. Low Deck (Item 58) rating may adversely affect Super (Item 59) rating, however; Super rating will not affect Deck rating



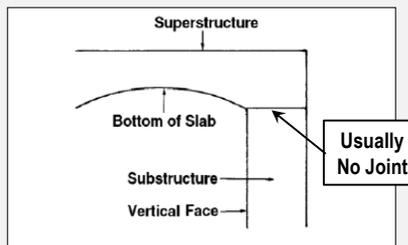
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Item 59 – Concrete Superstructure

3-Sided Precast Structures

- Top may be arched or flat
- Most common version is precast concrete
- Top is considered the Superstructure (Item 59)
- Sides are considered the Substructure (Item 60)
- Deck (Item 58) is coded “N”



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Item 59 – Concrete Superstructure

Key Indicators

- Cracks
- Scaling
- Spalls/Delams
- Section Loss

Code	Description
8	VERY GOOD. No significant defects, very minor shrinkage cracks, surface scaling, spalling or pop-outs which do not expose reinforcing steel.
7	GOOD. Isolated non-structural cracks up to 0.03", minor pop-outs or spalls without exposed primary reinforcing steel, stirrups may be exposed in a few locations.
6	SATISFACTORY. Extensive non-structural cracks up to 0.06", isolated hairline structural cracks, spalls and delaminations may be present on up to 10% of a beams cross section or 6' width of a slab with exposed primary reinforcement with surface rust only, up to 20% of a beam cross section or 6' width of a slab may be map cracked, spalled and delaminated. Spalls and delaminations up to 5% on the sides of a beam cross section.
5	FAIR. Non-structural cracks greater than 0.06", structural cracks up to 0.03", spalling with section loss of reinforcing steel up to 10% in a beam or 6' width of slab, up to 10% of compression surface area spalled or delaminated in a beam cross section or 6' width of slab. Up to 10% section loss of the concrete cross section.

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9/18/2020

Item 59 – Concrete Superstructure

Key Indicators

- Cracks
- Scaling
- Spalls/Delams
- Section Loss

Code	Description
4	POOR. Flexural or shear cracks up to 0.06", primary reinforcing steel exposed with section loss up to 30% in a 6' width of slab or in a beam cross section, up to 50% of the compression surface area spalled or delaminated , channel beams spalled or delaminated up to 30% section loss of the beam concrete cross section around the bottom primary reinforcement steel but not within 4' of beam ends.
3	SERIOUS. Primary reinforcing steel exposed with section loss up to 50% on a 6' width for slabs or cross section for beams, up to 100% section loss of compression surface area in a 6' width of slab or beam cross section, up to 50% section loss of the concrete cross section of a beam, channel beams spalled or delaminated around the bottom primary reinforcement steel within 4' of beam ends.
2	CRITICAL. Similar to the description for a condition rating of "3" although more extensive with over 50% loss of reinforcing steel, channel beams fully delaminated or spalled at ends with broken stirrups, requires special feature inspections, temporary support or repairs may be required to remain open to traffic. The Bureau of Bridges and Structures shall be notified immediately.

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Item 59 – Concrete Superstructure

New Superstructure

- Slab
- No Defects



New superstructure – Typically first inspection only

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9/18/2020

Item 59 – Concrete Superstructure

New Superstructure

- Channel Beam
- No Defects



New superstructure – Typically first inspection only

J-11

9/18/2020

Item 59 – Concrete Superstructure

Very Good Condition

- Slab
- No significant defects



VERY GOOD. No significant defects, very minor shrinkage **cracks**, surface **scaling, spalling** or pop-outs which do not expose reinforcing steel.

J-12

9/18/2020

Item 59 – Concrete Superstructure

Very Good Condition

- Channel Beam
- Minor shrinkage cracks in legs



VERY GOOD. No significant defects, very minor shrinkage **cracks**, surface **scaling**, **spalling** or pop-outs which do not expose reinforcing steel.

J-13

9/18/2020

Item 59 – Concrete Superstructure

Very Good Condition

- 3-Sided Precast
- No significant defects



VERY GOOD. No significant defects, very minor shrinkage **cracks**, surface **scaling**, **spalling** or pop-outs which do not expose reinforcing steel.

J-14

9/18/2020

Item 59 – Concrete Superstructure

Good Condition

- Slab
- Minor non-structural cracks less than 0.03" present



GOOD. Isolated non-structural **cracks** up to 0.03", minor pop-outs or **spalls** without exposed primary reinforcing steel, stirrups may be exposed in a few locations.

J-15

9/18/2020

Item 59 – Concrete Superstructure

Good Condition

- Through Girder
- Minor spalling without exposed reinforcement



GOOD. Isolated non-structural **cracks** up to 0.03", minor pop-outs or **spalls** without exposed primary reinforcing steel, stirrups may be exposed in a few locations.

J-16

9/18/2020

Item 59 – Concrete Superstructure

Good Condition

- 3-Sided Precast
- Non-structural cracks less than 0.03" present



GOOD. Isolated non-structural **cracks** up to 0.03", minor pop-outs or **spalls** without exposed primary reinforcing steel, stirrups may be exposed in a few locations.

J-17

9/18/2020

Item 59 – Concrete Superstructure

Satisfactory Condition

- Slab
- Non-structural cracks less than 0.06" present
- 7% of surface area is delaminated with leaching present over a 6' wide section



SATISFACTORY. Extensive non-structural **cracks** up to 0.06", isolated hairline structural **cracks, spalls and delaminations** may be present on up to 10% of a beams cross section or 6' width of a slab with exposed primary reinforcement with surface rust only, up to 20% of a beam cross section or 6' width of a slab may be map **cracked, spalled and delaminated**. Spalls and delaminations up to 5% on the sides of a beam cross section.

J-18

9/18/2020

Item 59 – Concrete Superstructure

Satisfactory Condition

- T-Beam
- Non-structural cracks less than 0.06" present
- 9% of a beam surface area has spalls, delaminations, and leaching present



SATISFACTORY. Extensive non-structural **cracks** up to 0.06", isolated hairline structural **cracks, spalls and delaminations** may be present on up to 10% of a beams cross section or 6' width of a slab with exposed primary reinforcement with surface rust only, up to 20% of a beam cross section or 6' width of a slab may be map cracked, spalled and delaminated. Spalls and delaminations up to 5% on the sides of a beam cross section.

J-19

9/18/2020

Item 59 – Concrete Superstructure

Satisfactory Condition

- Channel Beam
- Non-structural cracks less than 0.06" present
- 5% of a beams surface area has delaminations and map cracking
- Be sure cracks are due to delaminations!



SATISFACTORY. Extensive non-structural **cracks** up to 0.06", isolated hairline structural **cracks, spalls and delaminations** may be present on up to 10% of a beams cross section or 6' width of a slab with exposed primary reinforcement with surface rust only, up to 20% of a beam cross section or 6' width of a slab may be map cracked, spalled and delaminated. Spalls and delaminations up to 5% on the sides of a beam cross section.

J-20

9/18/2020

Item 59 – Concrete Superstructure

Satisfactory Condition

- 3-Sided Precast
- Tight non-structural cracks less than 0.06" present
- Leaching keyway



SATISFACTORY. Extensive non-structural cracks up to 0.06", isolated hairline structural cracks, spalls and delaminations may be present on up to 10% of a beams cross section or 6' width of a slab with exposed primary reinforcement with surface rust only, up to 20% of a beam cross section or 6' width of a slab may be map cracked, spalled and delaminated. Spalls and delaminations up to 5% on the sides of a beam cross section.

J-21

9/18/2020

Item 59 – Concrete Superstructure

Fair Condition

- Slab
- 8% spalls and delaminations present
- Less than 10% section loss in reinforcement over 6' width



FAIR. Non-structural cracks greater than 0.06", structural cracks up to 0.03", spalling with section loss of reinforcing steel up to 10% in a beam or 6' width of slab, up to 10% of compression surface area spalled or delaminated in a beam cross section or 6' width of slab. Up to 10% section loss of the concrete cross section.

J-22

9/18/2020

Item 59 – Concrete Superstructure

Fair Condition

- T-Beam
- Spalling and delaminations present
- 10% section loss in beam primary reinforcement



FAIR. Non-structural cracks greater than 0.06", structural cracks up to 0.03", **spalling with section loss** of reinforcing steel up to 10% in a beam or 6' width of slab, up to 10% of compression surface area spalled or delaminated in a beam cross section or 6' width of slab. Up to 10% section loss of the concrete cross section.

J-23

9/18/2020

Item 59 – Concrete Superstructure

Fair Condition

- Through Girder
- Isolated structural cracks less than 0.03" wide
- Spalling with 6% section loss in beam primary reinforcement



FAIR. Non-structural cracks greater than 0.06", **structural cracks** up to 0.03", **spalling with section loss** of reinforcing steel up to 10% in a beam or 6' width of slab, up to 10% of compression surface area spalled or delaminated in a beam cross section or 6' width of slab. Up to 10% section loss of the concrete cross section.

J-24

9/18/2020

Item 59 – Concrete Superstructure

Fair Condition

- Channel Beam
- Map cracking, delaminations, and leaching present on 10% of beam surface
- No significant section loss in exposed steel



FAIR. Non-structural cracks greater than 0.06", structural cracks up to 0.03", **spalling** with section loss of reinforcing steel up to 10% in a beam or 6' width of slab, up to 10% of compression surface area spalled or delaminated in a beam cross section or 6' width of slab. Up to 10% section loss of the concrete cross section.

J-25

9/18/2020

Item 59 – Concrete Superstructure

Fair Condition

- 3-Sided Precast
- 8% of surface area is spalled or delaminated
- 6% section loss in reinforcement



FAIR. Non-structural cracks greater than 0.06", structural cracks up to 0.03", **spalling with section loss** of reinforcing steel up to 10% in a beam or 6' width of slab, up to 10% of compression surface area spalled or delaminated in a beam cross section or 6' width of slab. Up to 10% section loss of the concrete cross section.

J-26

9/18/2020

Item 59 – Concrete Superstructure

Poor Condition

- Slab
- Spalling with exposed reinforcement present
- 15% section loss in primary reinforcement over a 6' width



POOR. Flexural or shear cracks up to 0.06", primary reinforcing steel exposed with **section loss** up to 30% in a 6' width of slab or in a beam cross section, up to 50% of the compression surface area **spalled or delaminated**, channel beams spalled or delaminated up to 30% section loss of the beam concrete cross section around the bottom primary reinforcement steel but not within 4' of beam ends.

J-27

9/18/2020

Item 59 – Concrete Superstructure

Poor Condition

- T-Beam
- Structural cracks near beam ends less than 0.06" in width
- Delaminations and widespread leaching present
- 25% section loss in beam primary reinf.



POOR. Flexural or shear **cracks** up to 0.06", primary reinforcing steel exposed with **section loss** up to 30% in a 6' width of slab or in a beam cross section, up to 50% of the compression surface area **spalled or delaminated**, channel beams spalled or delaminated up to 30% section loss of the beam concrete cross section around the bottom primary reinforcement steel but not within 4' of beam ends.

J-28

9/18/2020

Item 59 – Concrete Superstructure

Poor Condition

- Through Girder
- Spalled concrete with exposed reinforcement
- 20% section loss in exposed primary reinforcement



POOR. Flexural or shear cracks up to 0.06", primary reinforcing steel exposed with **section loss** up to 30% in a 6' width of slab or in a beam cross section, up to 50% of the compression surface area spalled or delaminated, channel beams spalled or delaminated up to 30% section loss of the beam concrete cross section around the bottom primary reinforcement steel but not within 4' of beam ends.

J-29

9/18/2020

Item 59 – Concrete Superstructure

Serious Condition

- Slab
- Concrete spalling with reinforcement exposed
- 35% section loss in exposed primary reinforcement
- Concrete cores may be needed



SERIOUS. Primary reinforcing steel exposed with **section loss** up to 50% on a 6' width for slabs or cross section for beams, up to 100% section loss of compression surface area in a 6' width of slab or beam cross section, up to 50% section loss of the concrete cross section of a beam, channel beams spalled or delaminated around the bottom primary reinforcement steel within 4' of beam ends.

J-30

9/18/2020

Item 59 – Concrete Superstructure

Serious Condition

- T-Beam
- Concrete spalling with reinforcement exposed
- 40% section loss in exposed primary reinforcement



SERIOUS. Primary reinforcing steel exposed with **section loss** up to 50% on a 6' width for slabs or cross section for beams, up to 100% section loss of compression surface area in a 6' width of slab or beam cross section, up to 50% section loss of the concrete cross section of a beam, channel beams spalled or delaminated around the bottom primary reinforcement steel within 4' of beam ends.

J-31

9/18/2020

Item 59 – Concrete Superstructure

Serious Condition

- Through Girder
- Concrete spalling with reinforcement exposed
- 35% section loss in exposed primary reinforcement



SERIOUS. Primary reinforcing steel exposed with **section loss** up to 50% on a 6' width for slabs or cross section for beams, up to 100% section loss of compression surface area in a 6' width of slab or beam cross section, up to 50% section loss of the concrete cross section of a beam, channel beams spalled or delaminated around the bottom primary reinforcement steel within 4' of beam ends.

J-32

9/18/2020

Item 59 – Concrete Superstructure

Serious Condition

- Channel Beam
- Concrete spalling with reinforcement exposed
- 35% section loss in exposed primary reinforcement



SERIOUS. Primary reinforcing steel exposed with **section loss** up to 50% on a 6' width for slabs or cross section for beams, up to 100% section loss of compression surface area in a 6' width of slab or beam cross section, up to 50% section loss of the concrete cross section of a beam, channel beams spalled or delaminated around the bottom primary reinforcement steel within 4' of beam ends.

J-33

9/18/2020

Item 59 – Concrete Superstructure

Critical Condition

- Channel Beam
- Concrete spalling with reinforcement exposed
- 40% section loss in primary reinforcement
- Broken stirrups at beam ends
- Bureau of Bridges and Structures should be notified immediately!



CRITICAL. Similar to the description for a condition rating of "3" although more extensive with over 50% **loss of reinforcing steel**, channel beams fully delaminated or **spalled at ends with broken stirrups**, requires special feature inspections, temporary support or repairs may be required to remain open to traffic. The Bureau of Bridges and Structures shall be notified immediately.

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9/18/2020

Item 59 – Concrete Superstructure

Critical Condition

- Slab
- Large spall with two layers of exposed reinforcement
- 50% section loss in bottom reinforcement
- Full-depth hole through slab above reinforcement
- Middle third of soffit is delaminated and sagging



CRITICAL. Similar to the description for a condition rating of “3” although more extensive with over 50% loss of reinforcing steel, channel beams fully delaminated or spalled at ends with broken stirrups, requires special feature inspections, temporary support or repairs may be required to remain open to traffic. The Bureau of Bridges and Structures shall be notified immediately.

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9/18/2020

Discussion

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9/18/2020

WATERWAY ADEQUACY

9/18/2020

NBI Calibration 2020

Item 71 – Waterway Adequacy

- Appraises the waterway opening with respect to passage of flow through the bridge
- Site conditions may warrant higher or lower ratings than indicated by the hydraulic table
- Requires knowledge of the history of high water elevations at the site

O-2

9/18/2020

Item 71 – Waterway Adequacy

Key Words

Descriptions for Chance of Overtopping:

Remote	Greater than 100 years
Slight	11 to 100 years
Occasional	3 to 10 years
Frequent	Less than 3 years

Adjectives Describing Traffic Delays:

Insignificant	Minor inconvenience. Highway passable in a matter of hours.
Significant	Traffic delays of up to several days.
Severe	Long term delays to traffic with resulting hardship.

O-3

9/18/2020

Item 71 – Waterway Adequacy

Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
N	N	N	Bridge not over a waterway.
9	9	9	Bridge deck and roadway approaches above flood water elevations (high water). Chance of overtopping is remote .
8	8	8	Bridge deck above roadway approaches. Slight chance of overtopping roadway approaches.
6	6	7	Slight chance of overtopping bridge deck and roadway approaches.
4	5	6	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with insignificant traffic delays.
3	4	5	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with significant traffic delays. *
2	3	4	Occasional overtopping of bridge deck and roadway approaches with significant traffic delays. *
2	2	3	Frequent overtopping of bridge deck and roadway approaches with significant traffic delays. *
2	2	2	Occasional or frequent overtopping of bridge deck and roadway approaches with severe traffic delays. *
0	0	0	Bridge closed.

O-4

9/18/2020

Item 71 – Waterway Adequacy

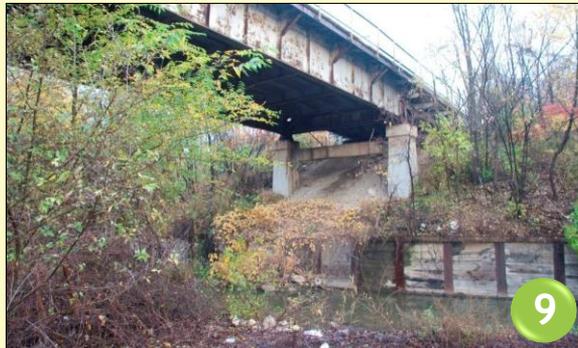


Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
N	N	N	Bridge not over a waterway.

O-5

9/18/2020

Item 71 – Waterway Adequacy



Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
9	9	9	Bridge deck and roadway approaches above flood water elevations (high water). Chance of overtopping is remote.

O-6

9/18/2020

Item 71 – Waterway Adequacy

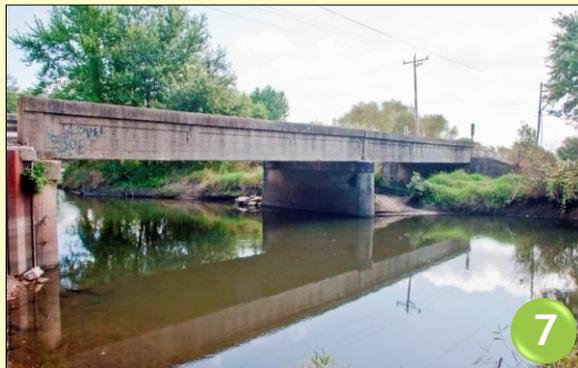


Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
8	8	8	Bridge deck above roadway approaches. Slight chance of overtopping roadway approaches.

O-7

9/18/2020

Item 71 – Waterway Adequacy



Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
6	6	7	Slight chance of overtopping bridge deck and roadway approaches.

O-8

9/18/2020

Item 71 – Waterway Adequacy



Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
4	5	6	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with insignificant traffic delays.

O-9

9/18/2020

Item 71 – Waterway Adequacy



Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
3	4	5	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with significant traffic delays. *

O-10

9/18/2020

Item 71 – Waterway Adequacy



Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
2	3	4	Occasional overtopping of bridge deck and roadway approaches with significant traffic delays. *

O-11

9/18/2020

Item 71 – Waterway Adequacy



Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
2	2	3	Frequent overtopping of bridge deck and roadway approaches with significant traffic delays. *

O-12

9/18/2020

Item 71 – Waterway Adequacy



Interstate	Other Principal and Minor Arterials and Major Collectors	Minor Collectors, Local	Description
2	2	2	Occasional or frequent overtopping of bridge deck and roadway approaches with severe traffic delays. *

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9/18/2020

Discussion

9/18/2020

SUBSTRUCTURES

9/18/2020

NBI Calibration 2020

Item 60 – Substructure Condition

Typical Elements

- Abutments
- Piers
- Piles
- Footings
- Fenders

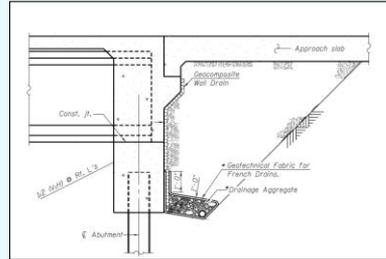


L-2

Item 60 – Substructure Condition

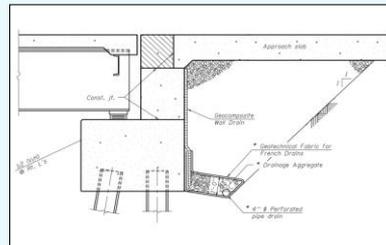
- **Integral Abutment**

Substructure is the portion of the bridge below the intersection of the bottom of the superstructure with the vertical wall face



- **Non-Integral Abutment**

- Substructure is the portion below the bearings
- Includes backwalls



L-3

9/18/2020

Item 60 – Substructure Condition

Temporary Shoring

- If left in place for 5 yrs. or more, temporary supports are considered the Substructure
- The rating coded for Item 60 would be based on the criteria for the material used for the former “temporary” support
- Steel shoring, similar to the example in the lower photo, becomes a Fracture Critical Member in the Substructure



L-4

9/18/2020

Item 60 – Substructure Condition

Pile Deterioration Problems

- **Exposed piling without concrete encasement:**
 - Steel Piling
 - Timber Piling
- **Accelerated deterioration possible:**
 - At the top where it meets the cap
 - At or just below the mud-line, in areas with frequent wetting and drying occurring



L-5

9/18/2020

Item 60 – Substructure Condition

IL County Bridge Failure

- Pier collapsed on 4 span bridge in September 2013
- Collapse immediately preceded by a < legal loads truck crossing bridge
- Failure of deteriorated piling was the cause



L-6

9/18/2020

Item 60 – Substructure Condition

IL County Failure

- Exposed steel H-Piles
- Accelerated deterioration and section loss occurred
 - At the water line
 - In areas with frequent wetting and drying
- Difficult location to easily see during inspection



Pier similar to the one that failed

L-7

9/18/2020

Item 60 – Substructure Condition

IL County Failure

Steel H-piling



Heavy section loss



Failed pile sections

L-8

9/18/2020

Item 60 – Substructure Condition

Pile Deterioration Problems

- Damaged Timber Piling
- Heavy deterioration found just below the mud-line



L-9

9/18/2020

Item 60 – Substructure Condition



2016 State Rte. Bridge closure in **Ohio** due to deteriorated exposed steel piles at the water line. SUBSTRUCTURE Rating was a "7".

Missouri DOT has reported seeing similar problems.



2016 Local Rte. Bridge closure in **Illinois** due to deteriorated exposed steel piles just below the pier cap.

L-10

9/18/2020

Item 60 – Substructure Condition

Exposed Pile Inspection:

Extra attention required during inspection!!

- **Check condition of piles at / below water / mud-line (12"-18")**
- **Return later to inspect during a low water period if necessary**
- **Timber Piles**
 - Sound piles with hammer full height
 - Core piles if hollow to determine section loss %
- **Steel Piles**
 - Also check top of pile at bottom of cap
 - Take thickness readings if necessary to determine section loss %
- **See IDOT CL 2014-15 on Exposed Bridge Piling**

L-11

9/18/2020

Item 60 – Substructure Condition

Underwater Inspection:

For substructures requiring underwater inspection that are not being completed by a diver:

- Verify stream cross section elevations
- Plot and compare new to previous cross section elevations
- Probe around footings to verify if they have been exposed
- Look for deterioration of the underwater portion of the substructure

L-12

9/18/2020

Item 60 – Substructure Condition

Key Indicators

- Cracks
- Scaling
- Spalling
- Delaminations
- Section Loss
- Scour
- Movement

Code	Description (CONCRETE OR MASONRY)
N	Culvert.
9	New substructure.
8	VERY GOOD. No significant defects. Shrinkage cracks , very light surface scaling , spalling or pop-outs which do not expose reinforcing steel. Insignificant damage caused by drift or collision with no misalignment and no corrective action warranted.
7	GOOD. Minor cracking , spalls or scaling with few incidences of exposed reinforcement with only surface rust. Minor scour may have occurred at the foundation.
6	SATISFACTORY. Moderate deterioration or disintegration, spalls , cracking and leaching on concrete or masonry units with up to 2% section loss or loss of bearing area . Shallow, local scour may have occurred near foundations with exposure of top of pile supported footings, less than 2' deep scour around pile bents. No exposed piles.

L-13

9/18/2020

Item 60 – Substructure Condition

Key Indicators

- Cracks
- Scaling
- Spalling
- Delaminations
- Section Loss
- Scour
- Movement

Section loss % based on the total of all primary reinf. at the section, not the individual bars.

Code	Description
5	FAIR. Large portions of concrete or masonry units are spalled , scaled , or delaminated with exposed reinforcing steel up to 10% loss of concrete (horizontal cross section), up to 10% loss of reinforcement steel, extensive map cracking with leaching, spread footings with no undermining on soil and up to 5% undermining on rock, less than 2' of exposed piles or seal coat below pile supported footings, less than 6' deep scour around pile bents, up to 10% section loss of bearing seats or piles .
4	POOR. Active cracks in concrete and masonry units that indicate a reduction in the substructure unit's capacity to support the superstructure loads, up to 30% section loss of bearing seat(s) or pile(s), section loss of primary steel reinforcement up to 30%. Section loss of concrete up to 30%, undermining of spread footing which may be affecting the stability of the unit but no significant settlement has yet occurred, worst condition or combination of deterioration stated in condition rating "5". If the rating of this item is due to scour , the rating for Item 113 shall be re-evaluated.

L-14

9/18/2020

Item 60 – Substructure Condition

Key Indicators

- Cracks
- Scaling
- Spalling
- Delaminations
- Section Loss
- Scour
- Movement

Code	Description
3	SERIOUS. Section losses up to 50%, loss of bearing seat area to cause more than 2" drop, adjacent column ties are broken causing the vertical reinforcement to be ineffective, severe scour or undermining of footings affecting the stability of the unit with some settlement of the substructure. If the rating of this item is due to scour , the rating for Item 113 shall be re-evaluated.
2	CRITICAL. Conditions worse than condition rating of "3", section loss greater than 50%, special feature inspection is required to allow bridge to remain open, measurable lateral or vertical movement , unstable structures. The Bureau of Bridges and Structures shall be notified immediately. If the rating of this item is due to scour, the rating for Item 113 shall be re-evaluated.

L-15

9/18/2020

Item 60 – Substructure Condition

New Construction

Note Integral Abutment



New substructure.

L-16

9/18/2020

Item 60 – Substructure Condition

Very Good Condition

Light surface scaling



VERY GOOD. No significant defects. Shrinkage cracks, very light surface **scaling**, spalling or pop-outs which do not expose reinforcing steel. Insignificant damage caused by drift or collision with no misalignment and no corrective action warranted.

L-18

9/18/2020

Item 60 – Substructure Condition

Good Condition

Minor cracking and scaling of the underside of the pier cap



GOOD. Minor **cracking**, spalls or **scaling** with few incidences of exposed reinforcement with only surface rust. Minor scour may have occurred at the foundation.

L-21

9/18/2020

Item 60 – Substructure Condition

Good Condition

- Minor cracking and scaling on piers
- Minor scour
- Very minor surface rust on FCM cap beam
- Steel sheet piling in good condition



GOOD. Minor **cracking**, spalls or **scaling** with few incidences of exposed reinforcement with only surface rust. Minor **scour** may have occurred at the foundation.

GOOD (Steel). Some **light surface rust**, minor scour may have occurred.

L-23

9/18/2020

Item 60 – Substructure Condition

Satisfactory Condition

- Minor spall on the corner of one bent with exposed reinforcement
- Minor spalls on concrete cap with no reinforcement exposed



SATISFACTORY. Moderate deterioration or disintegration, **spalls**, cracking and leaching on concrete or masonry units with up to 2% section loss or loss of bearing area. Shallow, local scour may have occurred near foundations with exposure of top of pile supported footings, less than 2' deep scour around pile bents. No exposed piles.

L-25

9/18/2020

Item 60 – Substructure Condition

Satisfactory Condition

The concrete backwall has leaching cracks throughout



SATISFACTORY. Moderate deterioration or disintegration, spalls, **cracking** and leaching on concrete or masonry units with up to 2% section loss or loss of bearing area. Shallow, local scour may have occurred near foundations with exposure of top of pile supported footings, less than 2' deep scour around pile bents. No exposed piles.

L-26

9/18/2020

Item 60 – Substructure Condition

Satisfactory Condition

- Defects include surface decay with cracking and splitting of timber piles
- Sound piles to check for hollow sections



SATISFACTORY. **Surface decay, cracking, splitting** of timber, fire damage limited to surface scorching of timber with up to 2% section loss, shallow, local scour may have occurred near foundations. No exposed piles.

L-27

9/18/2020

Item 60 – Substructure Condition

Fair Condition

- Large areas of cap are spalled with exposed reinforcement
- Section loss is 10% of total primary reinforcement in section



FAIR. Large portions of concrete or masonry units are **spalled**, scaled, or **delaminated** with exposed reinforcing steel up to 10% loss of concrete (horizontal cross section), up to 10% **loss of reinforcement** steel, extensive map cracking with leaching, spread footings with no undermining on soil and up to 5% undermining on rock, less than 2' of exposed piles or seal coat below pile supported footings, less than 6' deep scour around pile bents, up to 10% section loss of bearing seats or piles.

L-29

9/18/2020

Item 60 – Substructure Condition

Fair Condition

- Large areas of spalled and delaminated concrete on face of abutment
- Minor vertical cracks throughout



FAIR. Large portions of concrete or masonry units are **spalled**, scaled, or **delaminated** with exposed reinforcing steel up to 10% loss of concrete (horizontal cross section), up to 10% loss of reinforcement steel, extensive map **cracking** with leaching, spread footings with no undermining on soil and up to 5% undermining on rock, less than 2' of exposed piles or seal coat below pile supported footings, less than 6' deep scour around pile bents, up to 10% section loss of bearing seats or piles.

L-30

9/18/2020

Item 60 – Substructure Condition

Poor Condition

- Active cracks and spalls noted
- 22% loss in concrete cross section



POOR. Active cracks in concrete and masonry units that indicate a reduction in the substructure unit's capacity to support the superstructure loads, up to 30% section loss of bearing seat(s) or pile(s), section loss of primary steel reinforcement up to 30%. Section loss of concrete up to 30%, undermining of spread footing which may be affecting the stability of the unit but no significant settlement has yet occurred, worst condition or combination of deterioration stated in condition rating "5". If the rating of this item is due to scour, the rating for Item 113 shall be re-evaluated.

L-32

9/18/2020

Item 60 – Substructure Condition

Poor Condition

- Large area of spalled concrete under exterior beam
- Integrity of bearing seat reduced due to spalls



POOR. Active cracks in concrete and masonry units that indicate a reduction in the substructure unit's capacity to support the superstructure loads, up to 30% section loss of bearing seat(s) or pile(s), section loss of primary steel reinforcement up to 30%. Section loss of concrete up to 30%, undermining of spread footing which may be affecting the stability of the unit but no significant settlement has yet occurred, worst condition or combination of deterioration stated in condition rating "5". If the rating of this item is due to scour, the rating for Item 113 shall be re-evaluated.

L-33

9/18/2020

Item 60 – Substructure Condition

Poor Condition

- Widespread spalling of concrete on face of abutment
- Integrity of bearing seat reduced due to spalls up to 25%



POOR. Active cracks in concrete and masonry units that indicate a reduction in the substructure unit's capacity to support the superstructure loads, up to 30% **section loss** of bearing seat(s) or pile(s), section loss of primary steel reinforcement up to 30%. **Section loss** of concrete up to 30%, undermining of spread footing which may be affecting the stability of the unit but no significant settlement has yet occurred, worst condition or combination of deterioration stated in condition rating "5". If the rating of this item is due to scour, the rating for Item 113 shall be re-evaluated.

L-34

9/18/2020

Item 60 – Substructure Condition

Serious Condition

- Abutment undermined by scour
- Abutment stability affected



SERIOUS. Section losses up to 50%, loss of bearing seat area to cause more than 2" drop, adjacent column ties are broken causing the vertical reinforcement to be ineffective, severe **scour** or undermining of footings affecting the stability of the unit with some **settlement** of the substructure. If the rating of this item is due to **scour**, the rating for Item 113 shall be re-evaluated.

L-35

9/18/2020

Item 60 – Substructure Condition

Critical Condition

- Abutment undermined by scour
- Abutment corner has settled approximately 6"



CRITICAL. Conditions worse than condition rating of "3", section loss greater than 50%, special feature inspection is required to allow bridge to remain open, measurable lateral or vertical movement, unstable structures. The Bureau of Bridges and Structures shall be notified immediately. If the rating of this item is due to scour, the rating for Item 113 shall be re-evaluated.

L-36

9/18/2020

Item 60 – Substructure Condition

Critical Condition

- Concrete section loss of 55% in pier column
- Special Inspection required



CRITICAL. Conditions worse than condition rating of "3", section loss greater than 50%, special feature inspection is required to allow bridge to remain open, measurable lateral or vertical movement, unstable structures. The Bureau of Bridges and Structures shall be notified immediately. If the rating of this item is due to scour, the rating for Item 113 shall be re-evaluated.

L-37

9/18/2020

Item 60 – Substructure Condition

Failure Imminent

Notify the Bureau of Bridges and Structures immediately



Substructure in **“imminent failure”** condition requiring bridge closure or temporary measures to allow structure to remain open.

L-38

9/18/2020

Item 60 – Substructure Condition

Failure Imminent

- Tops of steel piles are cracked
- Abutment cap has displaced laterally causing instability
- Notify the Bureau of Bridges and Structures immediately



Substructure in **“imminent failure”** condition requiring bridge closure or temporary measures to allow structure to remain open.

L-39

9/18/2020

Item 60 – Substructure Condition

Failure Imminent

- 3 exposed piles have 100% section loss
- The 2 remaining piles are obscured by debris and may have similar loss of section
- Notify the Bureau of Bridges and Structures immediately



Substructure in **“imminent failure”** condition requiring bridge closure or temporary measures to allow structure to remain open.

L-40

9/18/2020

Discussion

L-41

9/18/2020

SCOUR & CHANNEL CONDITIONS

9/18/2020

NBI Calibration 2020

Scour Review

DEFINITIONS

- **Scour**: The removal of material from the streambed or embankment as a result of the erosive action of stream flow.
- **Scour Critical**: A bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition.

M-2

9/18/2020

Scour Review

TYPES OF SCOUR

- **General Scour**
- **Contraction Scour**
- **Local Scour**
- **Lateral Stream Migration**

M-3

9/18/2020

Scour Review

General Scour/Degradation

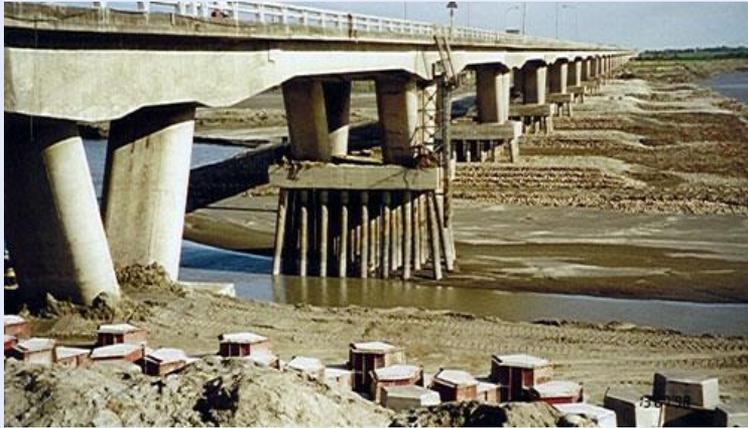
- **This is the gradual lowering of a streambed along a considerable length of waterway**
- **Occurs even if bridge crossing is not there**
- **Can be accelerated by:**
 - **Natural cutoffs in a meandering stream**
 - **Straightening or narrowing the channel**
 - **Dredging**

M-4

9/18/2020

Scour Review

General Scour/Degradation



M-5

9/18/2020

Scour Review

Contraction Scour

- This is the lowering of the streambed under the bridge only, resulting from accelerated stream flow due to reduced waterway opening
- Occurs when the bridge waterway opening is restrictive
- Can be caused by:
 - Embankments
 - Debris or Vegetation
 - Substructure units
 - Ice

M-6

9/18/2020

Scour Review

Contraction Scour



M-7

9/18/2020

Scour Review

Local Scour

- This is the lowering of the streambed adjacent to an obstruction in the waterway.
- Often much greater than general scour (up to 10 times)
- Often caused by:
 - Abutments
 - Wide, long, unusually shaped or poorly skewed piers
 - Streamflow depth (as depth increases vortex action is magnified)
 - Debris or Ice accumulation

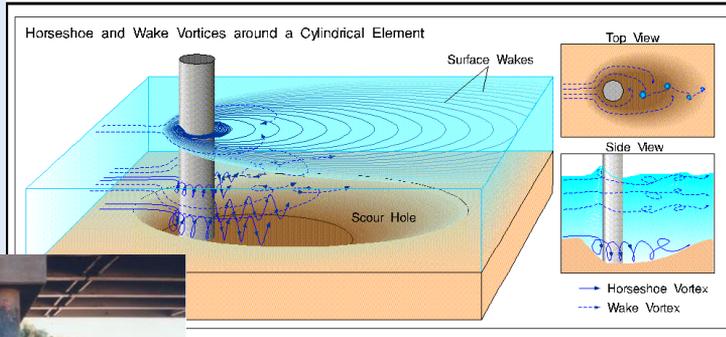
M-8

9/18/2020

Scour Review

Local Scour

(images from USGS)



M-9

9/18/2020

Scour Review

Lateral Stream Migration

- This is the relocation of the channel over time due to lateral scour of the embankment.
- Lateral stream migration process:
 - Bank damage
 - Sloughing bank
 - Undermined bank
 - Channel misalignment

M-10

9/18/2020

Scour Review

Lateral Stream Migration

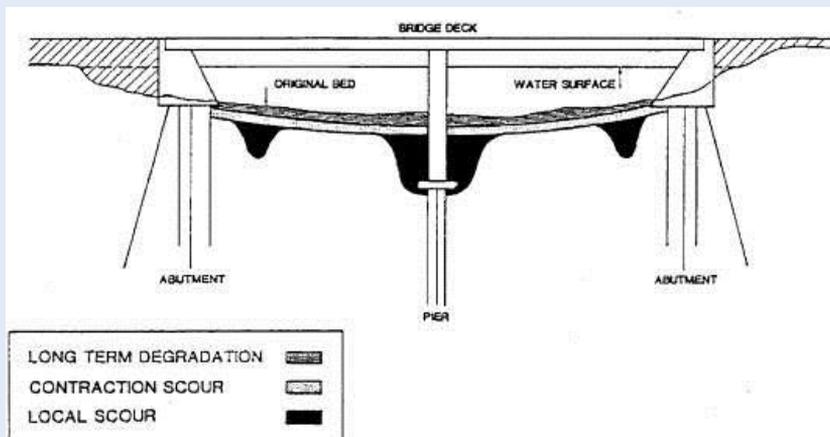


M-11

9/18/2020

Scour Review

Types Of Scour



M-12

9/18/2020

Scour Review

Scour Plans of Action

- Plans of Action (POA's) should be complete for all scour-critical bridges.
- Requirements are outlined in IDOT BLR&S Circular Letter 2007-05, CL 2007-21, and CL 2009-07.
- Plan of Action must be kept up-to-date to reflect changes in condition, personnel, and contact information.
- Documentation should be maintained in the bridge file for site visits made during activation of POA.

M-13

9/18/2020

Scour Review

Reporting Requirements for New Scour at Bridges

- **Scour Critical Bridge (ISIS Item-113 \leq 3)**
 - Scour \geq 25% as-built overburden on footing has occurred
 - Exposed top of footing or $>$ 6' of scour at a pile bent sub unit
- **Scour Susceptible Bridge (ISIS Item-113 = 4, 6 or 7)**
 - Scour \geq 50% as-built overburden on footing has occurred
 - Exposed top of footing or $>$ 6' of scour at a pile bent sub unit
 - The scour countermeasure has been damaged by scour
- **Other Bridges (ISIS Item-113 = 5, 8 or 9)**
 - Same as "Scour Susceptible Bridge"
- **Notify the responsible Program Manager and IDOT Bridge Management & Inspection Unit as soon as possible in these cases. Change ISIS Item-113 to "A" (new code indicating re-evaluation necessary).**

M-14

9/18/2020

Scour Review

Bridge Scour Monitoring System

- The NBIS require owners to monitor structures with known or potential scour deficiencies.
- IDOT has a contract to use **BRIDGE WATCH®** to assist with these efforts on the state & local system. (CL 2012-18)
 - Web based system
 - Monitors rainfall in drainage areas associated with bridges
 - Predicts when rainfall has created a predetermined storm event
- **Structures with a scour rating of 1 - 8 are monitored.**
- **Bridge Watch currently under review by IDOT for continued use/extent of use in the future.**

M-15

9/18/2020

Scour Review

Bridge Scour Monitoring System (BRIDGE WATCH®)

- This monitoring service assists in implementing Scour POA.
- Agencies with structures meeting this criteria have been contacted by IDOT.
- Warnings & Alerts are sent via text / email / fax.

Scour Rating	Storm Event			
	10 yr.	25 yr.	50 yr.	100 yr.
4 or Less	Warning	Alert		
5		Warning	Alert	
6	Warning	Alert		
7 or 8			Warning	Alert

M-16

9/18/2020

Item 61 – Channel Conditions

- **CHANNEL CONDITIONS - Describes the physical conditions associated with the flow of water through the bridge**
 - Stream stability
 - Condition of the channel
 - Condition of riprap, slope protection, and stream control devices including spur dikes
- **Inspectors should be particularly concerned with visible signs of excessive water velocity**
 - Undermining of slope protection or footings
 - Erosion of banks
 - Realignment of the stream

M-17

9/18/2020

Item 61 – Channel Conditions

Code	Description
N	NOT APPLICABLE. Use when bridge is not over a waterway.
9	EXCELLENT. There are no noteworthy deficiencies that affect the condition of the channel.
8	VERY GOOD. Banks are protected or well vegetated. River control devices such as spur dikes and embankment protection are not required or are in a stable condition.
7	GOOD. Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel may have minor amounts of drift not affecting the waterway opening.
6	SATISFACTORY. Bank is beginning to slump. River control devices and embankment protection have widespread minor damage. There is minor streambed movement evident. Debris is restricting the waterway slightly.
5	FAIR. Bank protection is being eroded . River control devices and/or embankment have major damage. Trees and brush restrict the channel.
4	POOR. Bank and embankment protection is severely undermined . River control devices have severe damage. Deposits of debris in the waterways are severely restricting the opening.
3	SERIOUS. Bank protection has failed . River control devices have been destroyed. Streambed aggradation, degradation or lateral movement has changed the waterway to now threaten the bridge and/or approach roadway.
2	CRITICAL. The waterway has changed to the extent the bridge is near a state of collapse.
1	IMMINENT FAILURE. Bridge closed. Corrective action may return bridge to light service.
0	FAILED. Bridge closed. Replacement necessary.

M-18

9/18/2020

Item 61 – Channel Conditions

Excellent Condition

- The Channel is well aligned
- Banks are vegetated



EXCELLENT. There are no noteworthy deficiencies that affect the condition of the channel.

M-19

9/18/2020

Item 61 – Channel Conditions

Very Good Condition

- The Channel is well aligned
- Banks are vegetated



VERY GOOD. Banks are protected or well vegetated. River control devices such as spur dikes and embankment protection are not required or are in a stable condition.

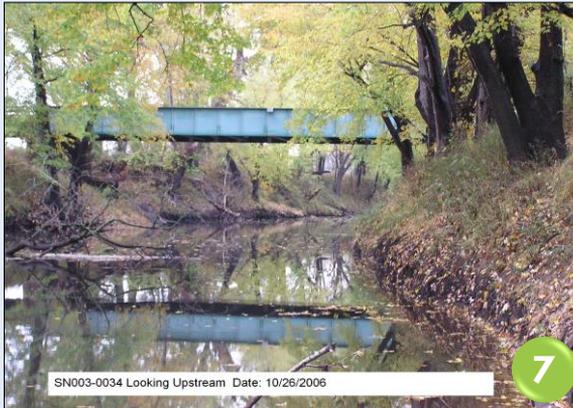
M-20

9/18/2020

Item 61 – Channel Conditions

Good Condition

- The Channel is well aligned
- Banks are in need of minor repair with removal of fallen trees
- Drift not affecting waterway opening



SN003-0034 Looking Upstream Date: 10/26/2006

GOOD. Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel may have minor amounts of **drift** not affecting the waterway opening.

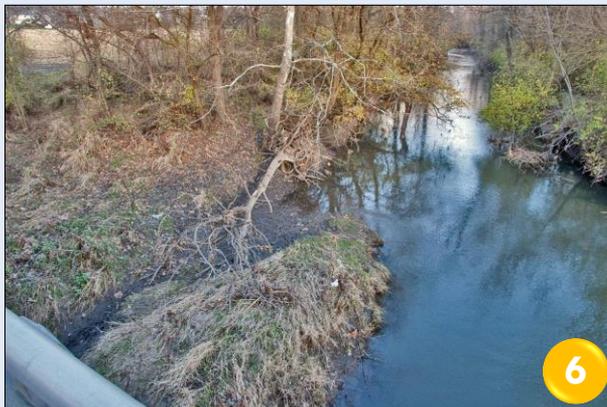
M-21

9/18/2020

Item 61 – Channel Conditions

Satisfactory Condition

- Minor streambed movement evident
- Banks are beginning to slump



SATISFACTORY. **Bank is beginning to slump.** River control devices and embankment protection have widespread minor damage. There is minor **streambed movement** evident. Debris is restricting the waterway slightly.

M-22

9/18/2020

Item 61 – Channel Conditions

Fair Condition

- Bank protection is being eroded
- Fallen trees are restricting the channel

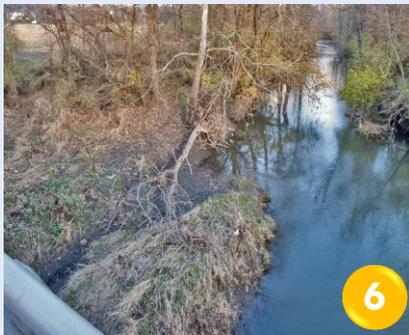


FAIR. Bank protection is being **eroded**. River control devices and/or embankment have major damage. Trees and brush restrict the channel.

M-23

9/18/2020

Item 61 – Channel Conditions



Debris is restricting waterway slightly.



Trees and brush restrict channel.

M-24

9/18/2020

Item 61 – Channel Conditions

Poor Condition

Debris is severely restricting the waterway.



POOR. Bank and embankment protection is severely undermined. River control devices have severe damage. **Deposits of debris in the waterways are severely restricting the opening.**

M-25

9/18/2020

Item 61 – Channel Conditions



Bank protection is being eroded.



Debris is severely restricting the waterway.

M-26

9/18/2020

Item 61 – Channel Conditions

Serious Condition

- Channel has shifted toward road
- Bank protection has failed
- Road and abutment threatened by erosion



SERIOUS. Bank **protection has failed**. River control devices have been destroyed. Streambed aggradation, degradation or **lateral movement has changed the waterway to now threaten the bridge and/or approach roadway.**

M-27

9/18/2020

Item 61 – Channel Conditions

Critical Condition

- Photo 1 of 2
- Banks are severely eroded
- Fallen trees are blocking channel



CRITICAL. The waterway has changed to the extent the bridge is near a state of collapse.

M-28

9/18/2020

Item 61 – Channel Conditions

Critical Condition

- Photo 2 of 2
- Bank erosion and debris in stream have redirected stream flow towards abutment
- Scour is undermining abutment and exposing caissons



CRITICAL. The waterway has changed to the extent the bridge is near a state of collapse.

M-29

9/18/2020

Discussion

M-30

9/18/2020

CONCLUSION

9/18/2020

NBI Calibration 2020

Conclusion

Our Course Objectives were to:

- 1. Improve the understanding of key indicators affecting bridge condition ratings to achieve consistent & accurate reporting***
- 2. Update participants on changes in policy and inspection methods***
- 3. Increase awareness of existing deficiencies in inventory data so they can be corrected***

Have we accomplished these objectives ?

T2-2

Conclusion

ADDITIONAL IDOT INSPECTION REFERENCES:

Bridge Inspection Reference Videos are Available on the IDOT Website under Inspections - NBI Inspection Standards.

1. *Calculating Section Loss in Steel Members*
2. *Completing IDOT Inspection Forms*
3. *Completing the IDOT Critical Finding Process*

T2-3

Conclusion

Questions?

T2-4