SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

BRIDGE INSPECTION
FIELD MANUAL

2025

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PREFACE

The South Dakota Bridge Inspection Field Manual has been developed to provide guidance to Department and consultant personnel performing bridge inspections, providing element level ratings, and preparing structure inspection reports for the SDDOT and local agencies as required under the National Bridge Inspection Standards (NBIS). The Manual is intended to comply with all State and Federal laws, statutes, and regulations, and it presents SDDOT criteria, practices, and procedures for performing National Bridge Inventory (NBI) bridge and structure inspections. As practical as possible, the user should follow the guidance presented in the Manual.

The Manual presents much of the information normally required for inspection, condition, and documentation of structure length bridges and culverts; however, it is impossible to address every situation that the user will encounter. Therefore, the user must exercise good engineering judgment during bridge inspections and must be innovative in the approach to address deficiencies, issues, and impacts. This may require, for example, additional research or different approaches than those described in this Manual.

It is also important to recognize that bridge inspection policies and procedures continue to evolve with time. New laws will be passed, new regulations developed, existing regulations revised, and new criteria issued. The methods described in this Manual are not intended to restrict consideration or use of these new developments. However, the user must evaluate the suitability of the method for the specific application. Where questions exist regarding the use of new methods, the user should seek guidance from the Bridge Maintenance Engineer or Local Government Assistance Bridge Inspection Engineer. After appropriate review, this Manual may be modified to include these new methods.

The South Dakota Bridge Inspection Field Manual was developed in coordination with the Office of Bridge Design, Region Bridge Offices, and the Local Government Assistance Office.

A special thanks to the Minnesota Department of Transportation and their Bridge Office personnel for their guidance, assistance, and use of their Bridge Inspection Field Manual as a starting point for South Dakota's manual.

The cover photo was taken by Broc Swanson of the Rapid City Region. Brett Mattice in the Communications Office created the cover with input from the Office of Bridge Design, Region Bridge Offices, Local Government Assistance Office, and the SD Division of FHWA.

SDDOT Bridge Inspection Program Organization/Flow Chart

Chief Bridge Engineer
Division of Planning & Engineering
Office of Bridge Design

NBIS Program Manager

Bridge Maintenance Engineer
Division of Planning & Engineering
Office of Bridge Design

Bridge Management Engineer
Division of Planning & Engineering
Office of Bridge Design

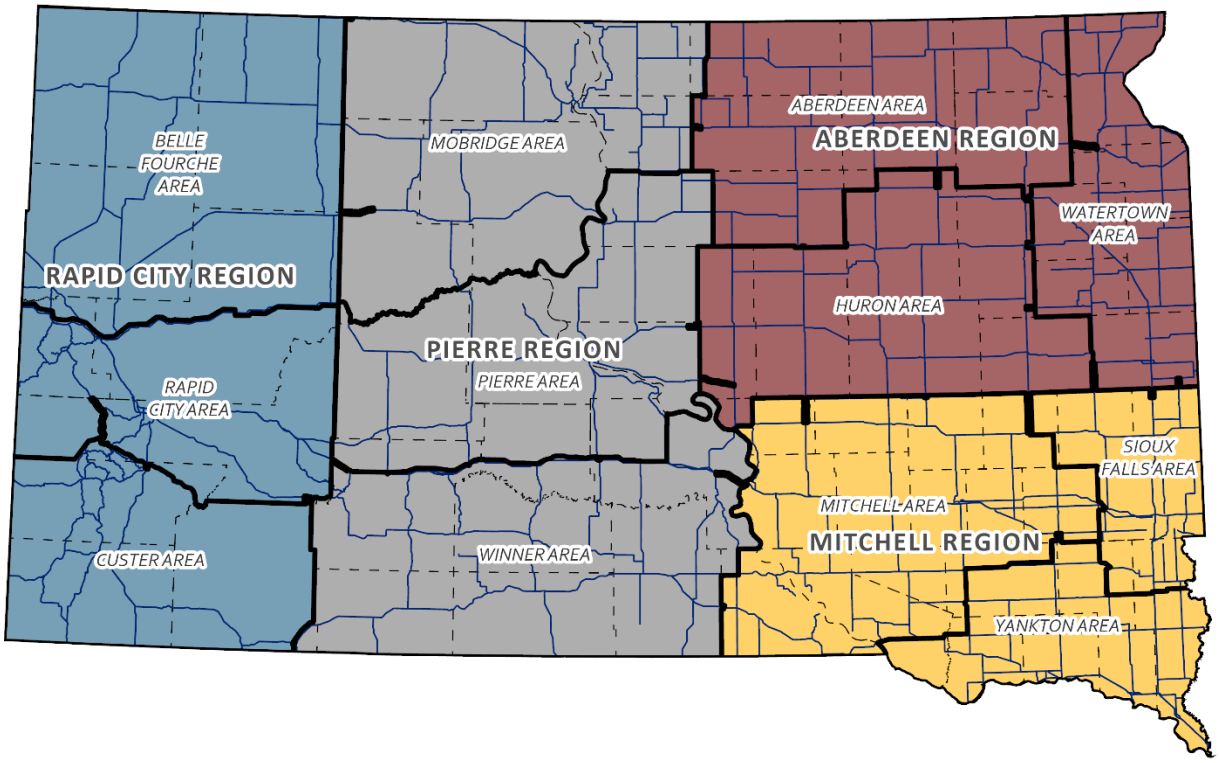
Operations Maintenance Engineer
Division of Operations
Operations Support Office

Local Government Assistance
Bridge Inspection Engineer
Division of Planning & Engineering
Administration Program - LGA

Consultant Inspectors

Region Bridge Engineers
Division of Operations
Aberdeen - Mitchell - Pierre - Rapid City

State Inspectors



Aberdeen Region

The Aberdeen Region encompasses the counties of Beadle, Brookings, Brown, part of Buffalo, Clark, Codington, Day, Deuel, most of Edmunds, Faulk, Grant, Hamlin, Hand, Hyde, Kingsbury, most of McPherson, Marshall, part of Miner, part of Moody, Roberts, and Spink. The region is divided into three Areas with the Area offices in Aberdeen, Huron, and Watertown. The Region office is in Aberdeen.

Mitchell Region

The Mitchell Region encompasses the counties of Aurora, Bon Homme, Brule, most of Buffalo, Charles Mix, Clay, Davison, Douglas, most of Gregory, Hanson, Hutchinson, Jerauld, Lake, Lincoln, part of Lyman, McCook, most of Miner, Minnehaha, most of Moody, Sanborn, Turner, Union, and Yankton. The Region is divided into three Areas with the Area offices in Mitchell, Sioux Falls, and Yankton. The Region office is in Mitchell.

Pierre Region

The Pierre Region encompasses the counties of Bennett, Campbell, Corson, Dewey, a portion of Edmunds and Gregory counties, Haakon, Hughes, part of Hyde, most of Jackson, Jones, most of Lyman, a portion of McPherson, Mellette, a portion of Oglala Lakota (formerly Shannon), Potter, Stanley, Sully, Todd, Tripp, Walworth, and most of Ziebach. The Region is divided into three Areas with the Area offices in Mobridge, Pierre, and Winner. The Region office is in Pierre.

Rapid City Region

The Rapid City Region encompasses the counties of Butte, Custer, Fall River, Harding, Lawrence, Meade, Pennington, portions of Jackson, most of Oglala Lakota (formerly Shannon), Perkins, and a portion of Ziebach. The Region is divided into three Areas with the Area offices in Belle Fourche, Custer, and Rapid City. The Region office is in Rapid City.

SD DEPARTMENT OF TRANSPORTATION

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1. OVERVIEW

This Manual is intended to serve as a field guide for the inspection and condition rating of bridges and culverts, that are structure length, on public roadways in South Dakota. A bridge inspection includes examining the structure, evaluating the physical condition of the structure, and reporting the observations and evaluations on a bridge inspection report. SDDOT currently uses two separate bridge condition rating systems - the NBI condition ratings and the structural element condition ratings:

- The NBI condition ratings describe the general overall condition of a bridge or culvert. This 0-9 rating system was developed by the Federal Highway Administration (FHWA) in 1971 and is outlined in the ″Specifications for National Bridge Inventory" (SNBI). The NBI condition ratings are used to determine inspection frequency and "bridge condition" (good/fair/poor as enacted in MAP21).

- Structural element condition ratings divide a bridge into separate components which are then rated individually based upon the severity and extent of deterioration. This 1-4 rating system was developed by the American Association of State Highway and Transportation Officials (AASHTO) and is outlined in the "AASHTO Manual for Bridge Element Inspection". South Dakota has been collecting element level bridge condition data since 1998. The FHWA began mandating (and collecting) element level data in October of 2014. SDDOT uses AASHTOWare BrM software for input of structural element condition ratings, which can be used to identify present maintenance needs and is intended to provide cost-effective options for long-range bridge maintenance and improvement programs (using computer projections of future deterioration).

Bridge inspection reports (along with the NBI & structural element condition ratings) are entered into the BrM database. Access to this system is typically restricted to SDDOT certified Bridge Inspection Team Leaders or Bridge Inspection Program Administrators appointed by those agencies with bridge inspection responsibility. A username and password are required. For more information, contact the Bridge Management Engineer.

1.1 COMMON ACRONYMS

- AASHTO American Association of State Highway and Transportation Officials
- ADE Agency Defined Element
- BIRM Bridge Inspector's Reference Manual
- BME Bridge Management Element
- BrM Bridge Management
- DOT Department of Transportation
- EA Each
- FHWA Federal Highway Administration
- LF Linear Foot
- LMC Latex Modified Concrete
- LSDC Low Slump Dense Concrete
- MBE Manual for Bridge Evaluation
- MBEI Manual for Bridge Element Inspection
- NBE National Bridge Element
- NBI National Bridge Inventory
- NBIS National Bridge Inspection Standards
- NDT Non-Destructive Testing
- NSTM Non-Redundant Steel Tension Member
- POA Plan of Action
- SDDOT South Dakota Department of Transportation
- SF Square Foot

- SNBI Specifications for the National Bridge Inventory
- UAS Unmanned Aerial System

1.2 COMMON INSPECTION TOOLS

- Cleaning Tools
  - Wire brush
  - Screw drivers
  - Brushes
  - Scrapers
- Inspection Tools
  - Pocket knife
  - Ice pick
  - Increment borer for timber elements
  - Chipping hammer
  - Chain drags
  - Plumb bob
- Visual Aid Tools
  - Binoculars
  - Flashlight
  - Magnifying glass
  - Dye penetrant
  - Inspection mirror
- Basic Measuring Equipment
  - Tape measure (various lengths)
  - Measuring wheel
  - Thermometer
  - Calipers
  - Carpenter’s level
  - D-Meter
  - Center punch
  - Simple surveying equipment
  - Crack gauges
- Recording Materials
  - Appropriate forms
  - Laptop or tablet (if applicable)
  - Clipboard
  - Chalk, paint sticks, lumber crayons, markers
  - Field books
  - Cameras
  - Extra pens and paper
- Safety Equipment
  - Rope
  - Harnesses
  - First aid kit
  - Cell phone
  - Life Jacket

- Miscellaneous Equipment
    - Dust masks
    - Coveralls
    - Gloves
    - Insect repellent
    - Wasp and hornet killer
    - Penetrating oil
    - Crampons or Yaktrax

See Chapter 2 of the Bridge Inspector's Reference Manual (BIRM) for a more comprehensive list.

1.3 TYPICAL ACCESS EQUIPMENT

- Waders
- Boats
- Rope/Rigging
- Ladders
- Aerial lifts or bucket trucks
- Under bridge inspection units

2. SNBI CONDITION AND APPRAISAL RATINGS

The NBI bridge condition and appraisal ratings were introduced in 1971 with the National Bridge Inspection Standards (NBIS). They were substantially revised and expanded with the 2022 FHWA Specifications for the National Bridge Inventory (SNBI). South Dakota has added some to improve consistency throughout the state.

2.1 SNBI BRIDGE CONDITION RATINGS

The SNBI condition ratings describe the general overall condition of a bridge or culvert. These must be reviewed during each inspection.

2.1.1 SNBI Bridge Component Condition Ratings

The SNBI component condition ratings describe the general overall condition of a bridge or culvert. The 13 SNBI condition rating items are rated on a numerical scale of 0 to 9, with "9" being “excellent” condition. The applicable SNBI condition ratings should be reviewed and adjusted (if necessary) during each inspection.

- Deck Condition Rating (SNBI Item B.C.01)
- Superstructure Condition Rating (SNBI Item B.C.02)
- Substructure Condition Rating (SNBI Item B.C.03)
- Culvert Condition Rating (SNBI Item B.C.04)
- Bridge Railing Condition Rating (SNBI Item B.C.05)
- Bridge Railing Transitions Condition Rating (SNBI Item B.C.06)
- Bridge Bearing Condition Rating (SNBI Item B.C.07)
- Bridge Joint Condition Rating (SNBI Item B.C.08)
- Channel Condition Rating (SNBI Item B.C.09)
- Channel Protection Condition Rating (SNBI Item B.C.10)
- Scour Condition Rating (SNBI Item B.C.11)
- NSTM Inspection Condition (SNBI Item B.C.14)
- Underwater Inspection Condition (SNBI Item B.C.15)

The general overall condition of a bridge is rated using three primary components - Deck (B.C.01), Superstructure (B.C.02), and Substructure (B.C.03). The Bridge Railing (B.C.05), Bridge Transition (B.C.06), Bridge Bearing (B.C.07), and Bridge Joint (B.C.08) condition items must also be rated if they are applicable.

- On filled spandrel arch or 3-sided frame bridges under fill, the SNBI Superstructure and Substructure items are rated, but the SNBI Deck item is entered as ″N″.
- For slab span bridges, the SNBI Deck and Superstructure ratings must be the same.

The general overall condition of a culvert is rated using a single component (SNBI Item B.C.04). This rating should consider the condition of the culvert barrel, joints, and seams, as well as any deflection, distortion, misalignment, settlement, scour, or voiding of backfill. Headwalls, wingwalls, and aprons up to the first construction joint should be included in this rating. The Bridge Railing (B.C.05) and Bridge Transition (B.C.06) items must also be rated if they are applicable.

The SNBI Channel (B.C.09) and Scour (B.C.11) condition items must be rated for all bridges and culverts over waterways. The SNBI Channel Protection (B.C.10) condition item is rated for most bridges and culverts over water but may be coded as “N” if channel protection is not required and has never existed.

The Nonredundant Steel Tension Member (NSTM) Inspection condition item (B.C.14) is typically rated only during NSTM inspections. The Underwater Inspection Condition item (B.C.15) is typically rated only during underwater inspections.

Temporary supports (shoring, bracing, or underpinning) should generally not improve the SNBI condition rating. The load carrying capacity should not be considered when determining SNBI condition ratings.

SDDOT has created a specific rating table for each SNBI component condition item. These rating tables are based on the general guidance in SNBI Table 20, the specific component guidance in SNBI section 7.1, and the defect tables in SNBI Appendix C. The guidance is formatted with bullet points for specific materials or items, so an inspector can clearly see the distinction between each condition level. The SDDOT tables are limited to one page per item, so all possible defects could not be included. If conditions are present that are not described in the tables, the inspector should use their best judgment when determining the component condition rating.

SNBI Bridge Component Condition Ratings - General Rating Guidelines		
Code	**Display**	**General Guidance**
N	**Not Applicable**	Component does not exist.
9	**New (Initial Entry)**	Component has not been assessed for condition.
8	**Very Good**	Some inherent defects.
7	**Good**	Some minor defects.
6	**Satisfactory**	Widespread minor or isolated moderate defects.
5	**Fair**	Some moderate defects. Strength and performance of the component is not affected.
4	**Poor**	Widespread moderate or isolated major defects. Strength and/or performance of the component is affected.
3	**Serious**	Major defects. Strength and/or performance of the component is seriously affected. Corrective actions, structural analysis, frequent monitoring, or load restrictions are typically required.
2	**Critical**	Major defects. Component is severely compromised. Frequent monitoring, significant load restrictions, or corrective actions required to keep the bridge open. Specific reporting and follow-up procedures are required for critical findings.
1	**Imminent Failure**	Bridge is closed to traffic due to component condition. Repair or rehabilitation may return the bridge to service.
0	**Failed**	Bridge is closed due to component condition and is beyond corrective action. Replacement is required to restore service.

SNBI Defect Definitions: SNBI Table 20 is based on a 4-level defect system similar to the AASHTO element-level defects.

- **Inherent Defect:** Superficial defect that is not indicative of damage or deterioration. An inherent defect is a normal characteristic of the material or results from standard fabrication or construction practices. Examples include shrinkage cracks or patched form holes in concrete, a rolling defect on a steel member, or a knot in a sawn timber beam.
- **Minor Defect:** Damage or deterioration has initiated but is not yet considered significant. Examples include light leaching cracks in concrete, surface corrosion on steel, or surface checking in timber.
- **Moderate Defect:** Damage or deterioration are significant, but the strength and performance of the component are not affected. Examples include moderate spalling in concrete, flaking rust on steel, or decay in timber.
- **Major Defect:** A major defect affects the strength and/or performance of the component. Examples include severe spalling in concrete, severe section loss on steel, or crushing of timber. For joints, bearings, railings, and railing transitions, a major defect prevents the component from functioning as intended.

A defect is considered “widespread” when it is present in many separate areas of the component, while an “isolated” defect occurs in one or a few concentrated locations. The term “some” is used when the defect prevalence is more than isolated and less than “widespread”.

2.1.2 Deck Condition Rating (SNBI Item B.C.01)

Deck Condition Rating (SNBI Item B.C.01)	
Code	This item describes the overall general condition of the deck (or slab). This item does not consider the condition of non-integral wearing surfaces, such as low slump concrete or bituminous overlays). The condition of railings, sidewalks, curbs, expansion joints, and deck drains are not considered in this item.
N	**Not Applicable:** Use for culverts, buried frames, or filled spandrel arch bridges.
9	**New (Initial Entry):** Deck has not been assessed for condition.
8	**Very Good Condition:** Deck has some inherent defects.
7	**Good Condition:** Deck has some minor defects. ▪ Concrete: Medium width cracks, light leaching, light salt/water saturation, light scale/abrasion, small delamination/spall (no exposed rebar), or sound patches. ▪ Timber: Minor weathering or checking (no splitting or decay). ▪ Steel: Surface corrosion. No section loss. Minor (superficial) impact damage. ▪ Deck components are secure and properly positioned (no loose fasteners).
6	**Satisfactory Condition:** Deck has widespread minor or isolated moderate defects. • Concrete: Widespread medium width cracks, light leaching/saturation, light scale/abrasion small delamination, or spall. Isolated wide cracks, heavy leaching/saturation, heavy scale/abrasion, rust staining, loose delamination, large spalls (exposed rebar), or unsound patch. ▪ Timber: Widespread checking. Isolated splitting, abrasion, or decay. Slight negative camber. • Steel: Extensive surface corrosion. Isolated flaking rust, pack rust, or section loss. Isolated impact damage (broken welds or torn grid members). • Components slightly loose or misaligned. Isolated loose or missing fasteners.
5	**Fair Condition:** Deck has some moderate defects. • Concrete: Wide cracks, heavy leaching/saturation, heavy scale/abrasion, rust staining, loose delamination, large spalls (exposed rebar), or unsound patches. • Timber: Moderate checks, splits, abrasion, or decay. Moderate negative camber. • Steel: Moderate flaking rust, pack rust, or section loss. Moderate impact damage (broken welds or torn grid members). • Components moderately loose or misaligned. Loose or missing fasteners.
4	**Poor Condition:** Deck has widespread moderate or isolated major defects. • Concrete: Widespread wide cracks, heavy leaching/saturation, scale/abrasion, rust staining, loose delamination, large spalls (exposed rebar), or unsound patch. Isolated severe cracks, deep spalls, or exposed rebar with significant section loss. • Timber: Widespread splitting, abrasion, or decay. Isolated significant decay or crushing. Significant negative camber. • Steel: Widespread (moderate) section loss or isolated (significant) section loss. Significant impact damage (broken welds or torn grid members). • Components significantly loose or misaligned. Numerous loose/missing fasteners.
3	**Serious Condition:** Deck has major defects. Strength or performance is seriously affected. Monitoring, load restrictions, or corrective actions may be required. • Concrete: Severe cracking, leaching, delamination, or spalling. Exposed rebar with severe section loss. Full-depth failures. • Timber: Severe splitting, decay, or crushing. Severe negative camber. • Steel: Severe section loss or impact damage. • Components severely loose, severely misaligned, or missing.
2	**Critical Condition:** Deck is severely compromised. Emergency repairs are required.
1	**"Imminent" Failure Condition:** Bridge is closed due to deck condition. Repair or rehabilitation may return the bridge to service.
0	**Failed Condition:** Bridge closed due to deck condition. Deck replacement required.

2.1.3 Superstructure Condition Rating (SNBI Item B.C.02)

Superstructure Condition Rating (SNBI Item B.C.02)	
Code	This item describes the overall general condition of the superstructure. This includes all primary structural members above the bearings (girders, beams, floorbeams, stringers, arches, spandrel walls, legs on K-frames, slabs, and top flanges on integral superstructures). This item does not consider bearings, secondary elements, or protective coatings. Well-formed patina on weathering steel is not a defect.
N	**Not Applicable:** Use for culverts.
9	**New (Initial Entry):** Superstructure has not been assessed for condition.
8	**Very Good Condition:** Some inherent defects. No impact damage present.
7	**Good Condition:** Minor defects. Superficial impact damage or distortion. • Steel: Minor surface corrosion. No section loss on primary members. • Concrete/Masonry: Minor cracking, leaching, scale, spalling (no exposed rebar), delamination, or mortar breakdown. Isolated and minor shear or flexure cracks on reinforced concrete (not prestressed) that are not growing in length or width. • Timber: Minor weathering or checking (no decay or sagging).
6	**Satisfactory Condition:** Widespread minor or isolated moderate defects. Primary members slightly bent, distorted, or misaligned. Connections have minor distress. • Steel: Extensive surface corrosion. Isolated flaking rust, pack rust, or section loss. Cracks have been arrested or pose no structural concern. • Concrete/Masonry: Widespread (minor) scale, cracking, leaching, sound patches, or mortar breakdown. Isolated (moderate) spall, delamination, rust staining, unsound patch, or block misalignment. Isolated or minor structural cracks. • Timber: Widespread checking. Isolated splitting, abrasion, or decay. Slight negative camber.
5	**Fair Condition:** Some moderate defects. Strength and performance are not affected. Members moderately bent, distorted, or misaligned. Loose or missing fasteners. • Steel: Moderate section loss. Un-arrested cracks that are unlikely to propagate. • Concrete/Masonry: Moderate scale, cracking, structural cracks, leaching, spall, delamination, rust staining, unsound patch, voided mortar, or block misalignment. • Timber: Moderate checks, splits, abrasion, or decay. Moderate negative camber.
4	**Poor Condition:** Widespread moderate or isolated major defects. Strength or performance is affected. Members significantly bent, distorted, or misaligned. Connections are significantly distressed (numerous loose or missing fasteners). • Steel: Widespread section loss or significant section loss in critical stress areas. Un-arrested cracks that could propagate into a critical stress area. • Concrete/Masonry: Widespread moderate scale, cracking, leaching, spall, delamination, rust staining, unsound patch, voided mortar, or block misalignment. Significant structural cracks. Exposed reinforcement with significant section loss. • Timber: Widespread splitting, abrasion, or decay. Isolated significant decay and/or crushing. Significant negative camber.
3	**Serious Condition:** Major defects. Strength and/or performance of the superstructure is seriously affected. Members severely bent or misaligned. Failed connections. • Steel: Severe section loss. Un-arrested cracks in critical stress areas. • Concrete/Masonry: Severe structural cracking, spalling, or block misalignment. • Timber: Severe splitting, decay, or crushing. Severe negative camber.
2	**Critical Condition:** Superstructure is severely compromised. Structural elements have critical deterioration, damage, or misalignment. Elements may be severed or detached. Immediate repairs may be required to prevent collapse or closure.
1	**Imminent Failure:** Bridge is closed due to superstructure condition. Repair or rehabilitation may return the bridge to service.
0	**Failed:** Bridge is closed due to superstructure condition (beyond corrective action).

2.1.4 Substructure Condition Rating (SNBI Item B.C.03)

Substructure Condition Rating (SNBI Item B.C.03)	
Code	This item describes the overall general condition of the substructure. This includes all structural components of the abutments and piers located below the bearings. Integral wingwalls or retaining walls up to the first construction joint are also included.
N	**Not Applicable:** Use for culverts.
9	**New (Initial Entry):** Substructure has not been assessed for condition.
8	**Very Good Condition:** Some inherent defects. No scour.
7	**Good Condition:** Minor defects. Minor (and isolated) scour or mitigated scour. Settlement, movement, or misalignment has been arrested or isn't a concern. • Concrete/Masonry: Minor cracking, leaching, scale, spalling (no exposed rebar), delamination, sound patches, or mortar breakdown. Isolated and minor shear or flexure cracks on pier caps that are not growing in length or width. • Timber: Minor weathering or checking (no decay). • Steel: Minor surface corrosion. No section loss on primary members.
6	**Satisfactory Condition:** Widespread minor or isolated moderate defects. Minor scour and/or isolated undermining. Minor settlement, movement, or misalignment. • Concrete/Masonry: Widespread (minor) scale, cracking, leaching, or mortar breakdown. Isolated (moderate) spall, delamination, rust staining, unsound patch, or block misalignment. Minor structural cracks (shear or flexure). • Timber: Widespread checking. Isolated splitting, abrasion, or decay. • Steel: Extensive surface corrosion. Isolated flaking rust, pack rust, or section loss. Cracks have been arrested or pose no structural concern.
5	**Fair Condition:** Some moderate defects. Strength and performance are not affected. Moderate scour, undermining, settlement, movement, or misalignment. • Concrete/Masonry: Moderate scale, cracking, structural cracks, leaching, spall, delamination, rust staining, unsound patch, voided mortar, or block misalignment. • Timber: Moderate checks, splits, abrasion, or decay. • Steel: Moderate section loss. Un-arrested cracks that are unlikely to propagate.
4	**Poor Condition:** Widespread moderate or isolated major defects. Strength or performance is affected. Extensive scour or undermining. Significant settlement, movement, or misalignment. • Concrete/Masonry: Widespread moderate scale, cracking, leaching, spall, delamination, rust staining, unsound patch, voided mortar, or block misalignment. Significant structural cracks. Exposed reinforcement with significant section loss. • Timber: Widespread splitting, abrasion, or decay. Isolated significant decay or crushing. • Steel: Widespread (moderate) section loss or significant section loss in critical stress areas. Un-arrested cracks that could propagate into a critical stress area.
3	**Serious Condition:** Major defects. Strength and/or performance of the substructure is seriously affected. Monitoring, load restrictions, or corrective actions may be required. Severe scour, undermining, settlement, movement, or misalignment. • Concrete/Masonry: Severe structural cracking, spalling, or block misalignment. • Timber: Severe splitting, decay, or crushing. • Steel: Severe section loss. Un-arrested cracks in critical stress areas.
2	**Critical Condition:** Substructure is severely compromised. Structural elements have critical deterioration, damage, or misalignment. Substructure is unstable due to scour, settlement, or movement. Immediate repairs required to prevent collapse or closure.
1	**Imminent Failure:** Bridge is closed due to substructure condition. Repair or rehabilitation may return the bridge to service.
0	**Failed:** Bridge is closed due to substructure condition (beyond corrective action).

2.1.5 Culvert Condition Rating (SNBI Item B.C.04)

Culvert Condition Rating (SNBI Item B.C.0.4)	
Code	This item describes the overall general condition of culvert structures. If this item is rated, the SNBI deck, superstructure, and substructure items must all be coded ″N″.
N	**Not Applicable:** Structure is not a culvert.
9	**New (Initial Entry):** Culvert has not been assessed for condition.
8	**Very Good Condition:** Culvert has some inherent defects. No scour or settlement.
7	**Good Condition:** Culvert has minor defects. Joints are sound and properly aligned. Scour or settlement has been mitigated or doesn't require mitigation. • Concrete/Masonry: Minor cracking, leaching, scale, spalling (no exposed rebar), delamination, sound patches, or mortar breakdown. • Steel: Minor surface corrosion (no flaking rust or section loss). No barrel distortion. • Timber: Minor weathering or checking (no decay, bowing, or sagging).
6	**Satisfactory Condition:** Culvert has widespread minor or isolated moderate defects. Minor joint separation, misalignment, or backfill infiltration). Minor scour or settlement. • Concrete/Masonry: Widespread (minor) scale, cracking, leaching, or mortar breakdown. Isolated (moderate) spall, delamination, rust staining, unsound patch, or block misalignment. • Steel: Extensive surface corrosion. Isolated flaking rust, pack rust, or section loss. Minor barrel distortion. Seams have minor distress, but no cracking. • Timber: Widespread checking. Isolated splitting, abrasion, or decay. Minor bowing or sagging.
5	**Fair Condition:** Culvert has some moderate defects. Strength and performance are not affected. Moderate joint separation, misalignment, or backfill infiltration. Moderate settlement, scour, or undermining. • Concrete/Masonry: Moderate scale, cracking, structural cracks, leaching, spall, delamination, rust staining, unsound patch, voided mortar, or block misalignment. • Steel: Moderate flaking rust, pack rust, or section loss. Moderate barrel distortion. Seams have moderate distress (isolated cracking or missing bolts). • Timber: Moderate checks, splits, abrasion, or decay. Moderate bowing or sagging.
4	**Poor Condition:** Culvert has widespread moderate or isolated major defects. Strength or performance is affected. Significant joint separation, misalignment, or backfill infiltration. Significant or extensive settlement, scour, or undermining. • Concrete/Masonry: Widespread scale, cracking, leaching, spall, delamination, rust staining, unsound patch, voided mortar, or block misalignment. Significant fractures. Exposed reinforcement with significant section loss. • Steel: Widespread flaking rust or section loss. Isolated through corrosion. Significant barrel distortion. Seams have significant distress (extensive cracking, missing bolts, or isolated failures). • Timber: Widespread splitting, abrasion, or decay. Isolated significant decay or crushing. Significant bowing or sagging.
3	**Serious Condition:** Culvert has major defects. Strength and/or performance is seriously affected. Monitoring, load restrictions, or repairs may be required. Severe joint separation, misalignment, loss of backfill, settlement, scour, or undermining. • Concrete/Masonry: Severe cracking, spalling, scale, or block misalignment. • Steel: Severe section loss, severe barrel distortion, or failed seams. • Timber: Severe splitting, decay, crushing, bowing, or sagging.
2	**Critical Condition:** Culvert is severely compromised. Immediate repairs or significant load restrictions required to prevent collapse or closure.
1	**Imminent Failure Condition:** Culvert is closed. Repair or rehabilitation may return the culvert to service.
0	**Failed Condition:** Culvert is closed and beyond repair - replacement is necessary.

2.1.6 Bridge Railing Condition Rating (SNBI Item B.C.05)

Bridge Railing Condition Rating (SNBI Item B.C.05)	
Code	This item describes the overall condition of the vehicular railings/barriers on the bridge. The rating considers all components of the railing or barrier (rail posts, rail beams, parapets, connections, and curbs). • This item includes guardrail above culverts that is not directly connected. • Do not consider pedestrian railing unless it is integral with the vehicular railing. • Do not consider the condition of protective coatings in this rating.
N	**Not Applicable:** Bridge doesn't carry vehicular traffic or has no vehicular railings.
9	**New (Initial Entry):** Vehicular railings have not been assessed for condition.
8	**Very Good Condition:** Railings have some inherent defects (no impact damage).
7	**Good Condition:** Railings have some minor defects. Minor impact damage. Connections are secure. • Concrete/Masonry: Minor cracking, leaching, scale, spalling (no exposed rebar), delamination, sound patches, or mortar breakdown. • Steel: Minor surface corrosion (no section loss). • Timber: Minor weathering or checking (no decay).
6	**Satisfactory Condition:** Railings have widespread minor or isolated moderate defects. Minor to moderate impact damage. Isolated loose connections. • Concrete/Masonry: Widespread (minor) scale, cracking, leaching, sound patches, or mortar breakdown. Isolated spall, delamination, rust staining, voided mortar, or block misalignment. • Steel: Extensive surface corrosion. Isolated flaking rust, pack rust, or section loss. • Timber: Widespread (minor) checking. Isolated splitting, abrasion, or decay.
5	**Fair Condition:** Railings have moderate defects. Moderate impact damage. Some loose connections. Strength and performance of the railing is not affected. • Concrete/Masonry: Moderate scale, cracking, leaching, spall, delamination, rust staining unsound patch, voided mortar, or block misalignment. • Steel: Moderate flaking rust, pack rust, or section loss. • Timber: Moderate checks, splits, abrasion, or decay.
4	**Poor Condition:** Railings have widespread moderate or isolated major defects. Moderate impact damage. Isolated failed connections. Strength and/or performance of the railing has been affected. • Concrete/Masonry: Widespread scale, cracking, leaching, spall, delamination, rust staining, unsound patch, voided mortar, or block misalignment. Significant fractures. Exposed reinforcement with significant section loss. • Steel: Widespread flaking rust or pack rust. Significant section loss. • Timber: Widespread splitting, abrasion, or decay. Isolated significant decay or crushing.
3	**Serious Condition:** Railings have major defects. Severe impact damage or failed connections. Strength and/or performance of the railing has been seriously affected. • Concrete/Masonry: Severe cracking, spalling, scale, or block misalignment. • Steel: Severe section loss. • Timber: Severe decay or crushing.
2	**Critical Condition:** Railings have major defects and are severely compromised (critical impact damage or deterioration).
1	**Imminent Failure Condition:** Bridge is closed due to railing condition (corrective action might return the structure to restricted service).
0	**Failed Condition:** Bridge is closed due railing condition and is beyond corrective action (railing replacement required).

2.1.7 Bridge Railing Transition Condition Rating (SNBI Item B.C.06)

Bridge Railing Transition Condition Rating (SNBI Item B.C.06)	
Code	This item describes the condition of the transition from the vehicular bridge railing to the approach guardrail. This typically extends about 20-25 ft. from the bridge ends. • This item must be rated for culverts with guardrail along the roadway above. The rating should consider the portion of the guardrail 3 posts from the culvert ends. • This item includes the portions of the railings, end posts, guardrail, crash cushions, blocking, guardrail posts, and curbs within the railing transitions.
N	**Not Applicable:** Bridge doesn't carry vehicular traffic or has no approach guardrail.
9	**New (Initial Entry):** Railing transitions have not been assessed for condition.
8	**Very Good Condition:** Transitions have some inherent defects (no impact damage).
7	**Good Condition:** Transitions have some minor defects. Minor impact damage. Connections are secure. • Concrete/Masonry: Minor cracking, leaching, scale, spalling (no exposed rebar), delamination, sound patches, or mortar breakdown. • Steel: Minor surface corrosion (no section loss). • Timber: Minor weathering or checking (no decay).
6	**Satisfactory Condition:** Transitions have widespread minor or isolated moderate defects. Minor to moderate impact damage. Isolated loose connections. • Concrete/Masonry: Widespread (minor) scale, cracking, leaching, or mortar breakdown. Isolated spall, delamination, rust staining, voided mortar, or block misalignment. • Steel: Extensive surface corrosion. Isolated flaking rust, pack rust, or section loss. • Timber: Widespread (minor) checking. Isolated splitting, abrasion, or decay.
5	**Fair Condition:** Transitions have moderate defects. Moderate impact damage. Some loose connections. Strength and performance of the transitions are not affected. • Concrete/Masonry: Moderate scale, cracking, leaching, spall, delamination, rust staining, voided mortar, or block misalignment. • Steel: Moderate flaking rust, pack rust, or section loss. • Timber: Moderate checks, splits, abrasion, or decay.
4	**Poor Condition:** Transitions have widespread moderate or isolated major defects. Moderate impact damage. Isolated connection failure. Strength and/or performance of the transitions has been affected. • Concrete/Masonry: Widespread scale, cracking, leaching, spall, delamination, rust staining, voided mortar, or block misalignment. Significant fractures. Exposed reinforcement with significant section loss. • Steel: Widespread flaking rust or pack rust. Significant section loss. • Timber: Widespread splitting, abrasion, or decay. Isolated significant decay or crushing.
3	**Serious Condition:** Transitions have major defects. Severe impact damage or failed connections. Strength and/or performance have been seriously affected. • Concrete/Masonry: Severe cracking, spalling, scale, or block misalignment. • Steel: Severe section loss. • Timber: Severe decay or crushing
2	**Critical Condition:** Transitions have major defects and are severely compromised (critical impact damage or deterioration).
1	**Imminent Failure Condition:** Bridge is closed due to railing transition condition (corrective action might return the structure to restricted service).
0	**Failed Condition:** Bridge is closed due railing transition condition and is beyond corrective action (transition replacement is required).

2.1.8 Bridge Bearing Condition Rating (SNBI Item B.C.07)

Bridge Bearing Condition Rating (SNBI Item B.C.07)	
Code	This item describes the overall condition of the bridge bearings. This includes elastomeric, expansion, fixed, pot, disc, and hinge bearings. This rating does not consider the condition of protective coatings on steel bearing components.
N	**Not Applicable:** Use for culverts or bridges without bearing elements.
9	**New (Initial Entry):** Bearings have not been assessed for condition.
8	**Very Good Condition:** Bearings have some inherent defects.
7	**Good Condition:** Bearings have some minor defects. • Minor and isolated restriction or misalignment. • Minor and isolated pad deterioration. • Bearing components have surface corrosion or minor wear. • Connections are secure. • Anchorages, connections, guides, or restraints have minor deterioration. • Some bearings have a minor loss of bearing area (less than 5%).
6	**Satisfactory Condition:** Widespread minor or isolated moderate defects. • Minor restriction or misalignment (within limits of expansion/contraction). • Minor pad deterioration. Isolated bulging or splitting of pad covering. • Bearing components have minor to moderate wear or deterioration. • Widespread surface corrosion. Isolated flaking rust, pack rust, or section loss. • Isolated loose/missing fasteners or broken welds. • Anchorages, guides, or restraints have minor to moderate deterioration. • Some bearings have a minor loss of bearing area (5% - 10%).
5	**Fair Condition:** Some moderate defects. • Moderate restriction or misalignment (near limits of expansion/contraction). • Moderate pad deterioration (bulging or splitting of pad covering). • Bearing components have moderate wear or deterioration. • Moderate flaking rust, pack rust, or section loss. • Some missing/loose fasteners or broken welds. • Anchorages, guides, or restraints have moderate deterioration (still functioning). • Some bearings have a moderate loss of bearing area (10% - 25%).
4	**Poor Condition:** Widespread moderate or isolated major defects. • Significant restriction or misalignment (at limits of expansion/contraction). • Significant pad deterioration (bulging, splitting, or corroded internal plates) • Bearing components have significant wear or deterioration. • Widespread flaking rust or pack rust. Significant section loss. • Numerous missing/loose fasteners or broken welds. • Anchorages have significant damage or deterioration (isolated anchorage failure). • Guides or restraints are not functioning as intended. • Some bearings have a significant loss or bearing area (25%-50%).
3	**Serious Condition:** Major defects. Bearing capacity or function is seriously affected. Frequent monitoring, load restrictions, or corrective actions may be required. • Severely restricted (frozen) or misaligned (beyond limits of expansion/contraction). • Bearing components severely deteriorated, failed, or missing. • Bearing anchorage failure or guide/restraint system failure. • Some bearings have a severe loss of bearing area (more than 50%).
2	**Critical Condition:** Critical bearing issue requiring immediate corrective action.
1	**Imminent Failure Condition:** Bridge is closed due to bearing issues. Repair or rehabilitation may return the bridge to service.
0	**Failed Condition:** Bridge is closed due to bearing issues and is beyond corrective action (replacement required).

2.1.9 Bridge Joint Condition Rating (SNBI Item B.C.08)

Bridge Joints Condition Rating (SNBI Item B.C.08)	
Code	This item describes the overall condition of deck joints on the bridge. The rating includes all joint components, such as seals, glands, extrusions, plates, cover plates (sidewalk, curb, or railing), protection angles, headers, supports, and connections. • Do not consider poured joints unless they are designed to accommodate bridge expansion/contraction (most do not). • Do not consider approach relief joints in this rating. • Leakage should be considered if it is impacting the structure below the joint. • If the joint is not visible (covered by bituminous or gravel), the condition should be assessed based on indirect indicators of the condition, such as leakage.
N	**Not Applicable:** Bridge does not have any deck joints.
9	**New (Initial Entry):** Joints have not been assessed for condition.
8	**Very Good Condition:** Joints have some inherent defects. No leakage.
7	**Good Condition:** Joints have some minor defects. No leakage. • No joint restriction or misalignment. Gaps are within design limits. • Steel Plates/Extrusions: Minor damage or surface corrosion (no section loss). • Header: Isolated minor cracking, scale, delamination, or spalling.
6	**Satisfactory Condition:** Joints have widespread minor or isolated moderate defects. No leakage. • Minor joint restriction or misalignment. Gaps are within design limits. • Extrusions or Steel Plates: Extensive surface corrosion. Isolated flaking rust, pack rust, or damage. Loose curb or rail plates. • Supports or equalizers have minor deterioration or misalignment. • Header: Widespread minor cracking, scale, delamination, or spalling.
5	• **Fair Condition:** Joints are leaking (glands pulled out or torn), but the leakage is not causing any damage to structural components.
4	**Poor Condition:** Joints have widespread moderate or isolated major defects (repair recommended). No leakage. • Moderate joint restriction or misalignment. Gaps are near the design limits. • Extrusions or Steel Plates: Moderate flaking rust, pack rust, section loss, or damage. Roadway or sidewalk plates slightly loose. Missing curb or rail plates. • Supports or equalizers moderately deteriorated, loose, or misaligned. • Header: Moderate cracking, scale, delamination, or spalling. Spalls present above extrusion anchorages.
3	**Serious Condition:** Joints are leaking (glands pulled out or torn), and joint leakage is causing damage to a structural component. The glands can be repaired or replaced, and the joint does not need to be reconstructed.
2	**Failed (Unrelated to Leakage):** Joints have major defects and need replacement. No leakage. • Severe joint restriction or misalignment (tightly closed or open beyond limits). • Extrusions: Anchorages have failed (extrusion separated from deck). • Steel Plates: Roadway or sidewalk plates severely loose, rusted through, fractured, damaged, or missing. • Joint supports or equalizers severely deteriorated, loose, or misaligned. Header: Severe cracking, scale, delamination, or spalling deterioration.
1	**Failed (Severe Leakage):** Joint leakage is causing damage to a structural component. Joint has failed (beyond repair and needs replacement). Extrusions can no longer hold glands/seals in place.
0	**Failed (Safety Hazard):** Bridge is closed due to joint condition.

2.1.10 Channel Condition Rating (SNBI Item B.C.09)

Channel Condition Rating (SNBI Item B.C.09)	
Code	This item describes the overall general condition of the waterway under the bridge or running through a culvert. This includes the channel immediately upstream and downstream from the bridge (typically those areas visible from the bridge). The rating may be based upon findings from routine inspections, soundings, or underwater inspections. This item must be rated for all bridges over water, even if the channel is occasionally dry. This item must be rated for all culvert structures (do not code culverts as "N"). • Changes in the channel (aggradation, degradation, or lateral stream migration) that might adversely affect the bridge should be considered in the rating. • The presence of debris or sediment in the channel, debris lodged against the bridge, or sediment inside culvert barrels should be considered in the rating. • Channel protection is addressed separately under Item B.C.10.
N	**Not Applicable:** Bridge is not over a waterway (culverts cannot be coded "N").
9	**New (Initial Entry):** Channel has not been assessed for condition.
8	**Very Good Condition:** Inherent defects only. • Channel banks have little or no bank erosion. • Channel is properly aligned with the structure. • Debris or sediment in the channel is incidental.
7	**Good Condition:** Some minor defects. • Minor bank erosion. Any channel movement is minor and isolated. • Channel flow angle is within 15° of the structure (5° for pier walls). • Minor debris or sediment in the channel.
6	**Satisfactory Condition:** Widespread minor or isolated moderate defects. • Isolated erosion or sloughing of banks. • Minor channel aggradation, degradation, or lateral movement. • Channel flow angle diverges 15°- 30° from the structure (5°- 15° for pier walls). • Channel is slightly restricted by debris or sediment deposits.
5	**Fair Condition:** Moderate defects. Bridge and approach roadway are not threatened. • Moderate bank erosion or sloughing, • Moderate channel aggradation, degradation, or lateral movement. • Channel flow angle diverges 30°- 45° from the structure (15°- 30° for pier walls). • Channel is moderately restricted by debris or sediment deposits.
4	**Poor Condition:** Widespread moderate or isolated major defects. Bridge and/or approach roadway is threatened. • Significant bank erosion or sloughing. • Significant channel aggradation, degradation, or lateral movement. • Channel flow angle diverges more than 45° from the structure (30° for pier walls). • Channel is significantly restricted by debris or sediment deposits.
3	**Serious Condition:** Major defects. Bridge or approach roadway is severely threatened. Monitoring or corrective actions may be required. • Severe bank erosion or sloughing. • Severe channel aggradation, degradation, or lateral movement. • Channel is severely restricted by debris or sediment deposits.
2	**Critical Condition:** Major defects. Immediate corrective action is required. • Bank erosion or channel aggradation, degradation, or lateral movement are critically threatening the structure or approaches. • Channel is critically restricted by debris or sediment deposits.
1	**Bridge closed due to channel condition:** Rehabilitation required to restore service.
0	**Bridge closed due to channel condition:** Bridge replacement is necessary.

2.1.11 Channel Protection Condition Rating (SNBI Item B.C.10)

Channel Protection Condition Rating (SNBI Item B.C.10)	
Code	This item describes the condition of channel protection countermeasures intended to mitigate stream instability or scour problems at a bridge or culvert. • Armoring countermeasures may consist of loose riprap, partially or fully grouted riprap, concrete paving, stone or concrete blocks, flood walls, gabion mattresses, grout-filled mats, or other materials. This includes protection along channel banks, in the stream, around piers, on abutment slopes, or on culvert embankments. • River training countermeasures may include spurs, check dams, guide banks, or other structures intended to arrest channel migration, degradation, or scour. When rating this item, consider erosion, scour, displacement, separation, settlement, material defects, or other factors impacting the effectiveness of the channel protection.
N	**Not Applicable:** Bridge does not cross over water or channel protection is not required and has never existed.
9	**New (Initial Entry):** Channel protection has not been assessed for condition.
8	**Very Good Condition:** Channel protection has some inherent defects. • No scour or erosion.
7	**Good Condition:** Channel protection has some minor defects. • Riprap (or other protection) has minor settlement, displacement, or deterioration. Minor scour or erosion. No undermining of the channel/slope protection. • River training countermeasures (if present) have minor deterioration.
6	**Satisfactory Condition:** Channel protection has widespread minor defects or isolated moderate defects. • Riprap (or other protection) has minor to moderate settlement, displacement, or deterioration. Minor to moderate scour or erosion. Isolated (minor) undermining of channel protection or isolated area(s) of missing channel protection. • River training countermeasures (if present) have minor to moderate deterioration.
5	**Fair Condition:** Channel protection has some moderate defects. Performance of the channel protection is not affected. • Riprap (or other protection) has moderate settlement, displacement, or deterioration. Moderate scour or erosion. Moderate undermining of channel protection or moderate area(s) of missing channel protection. • River training countermeasures (if present) have moderate deterioration but are still functioning as intended.
4	**Poor Condition:** Widespread moderate or isolated major defects. Performance of channel protection is affected. • Riprap (or other protection) has significant settlement, displacement, or deterioration. Significant scour or erosion. Significant undermining of channel protection or large area(s) of missing channel protection. • River training countermeasures (if present) have deteriorated to the extent that the function has been affected.
3	**Serious Condition:** Major defects. Performance of channel protection or river training countermeasures is seriously affected. Severe scour or erosion. Severe deterioration of channel protection or large area(s) of missing protection. Severe damage to river training countermeasures. Monitoring or corrective action may be required
2	**Critical Condition:** Major defects. Immediate corrective action is required.
1	**Bridge closed due to channel protection condition:** Protection must be replaced.
0	**Bridge closed due to channel protection condition:** Bridge replacement required.

2.1.12 Scour Condition Rating (SNBI Item B.C.11)

Scour Condition Rating (SNBI Item B.C.11)	
Code	This item describes the presence and severity of scour at the bridge (or culvert), based on observed conditions or measurements. This rating is focused on the presence of scour adjacent to abutments, piers, or culverts. Scour may result in scour holes, footing exposure, undermining, or loss of embankment. Footings designed to be exposed are not considered to be a defect. This rating may be based upon findings from routine inspections, soundings, or underwater inspections. This item must be rated for all bridges over water, even if the channel is occasionally or predominately dry. This item must be rated for all culvert structures (do not code culverts as "N").
N	**Not Applicable:** Bridge is not over a waterway (culverts cannot be coded as "N").
9	**New (Initial Entry):** Presence or extent of scour has not been determined.
8	**Very Good Condition:** No scour.
7	**Good Condition:** Some minor scour. • No exposure of footings or undermining of structure.
6	**Satisfactory Condition:** Widespread minor or isolated moderate scour. • Isolated scour holes (moderate depth). • Isolated footing exposure or undermining (not impacting strength or stability). • Minor embankment loss or streambed degradation.
5	**Fair Condition:** Moderate scour. Strength and stability of the bridge are not affected. • Moderate depth scour holes. • Moderate footing exposure (not impacting strength or stability). • Moderate undermining of structure, footings, or abutment backing (not impacting strength or stability). • Moderate embankment loss or streambed degradation.
4	**Poor Condition:** Widespread moderate or isolated major scour. Strength and/or stability of the bridge is affected. • Widespread scour (moderate depth) or isolated severe scour. • Significant footing exposure or undermining of structure, footings, or abutment backing. • Significant embankment loss or streambed degradation.
3	**Serious Condition:** Major scour. Strength and/or stability of the bridge is seriously affected. Condition typically necessitates more frequent monitoring, load restrictions, and/or corrective actions. • Severe scour. • Severe footing exposure. Severe undermining of structure, footings, or abutment backing. • Severe embankment loss or streambed degradation.
2	**Critical Condition:** Major scour. Strength and/or stability of the bridge is severely compromised. Condition typically necessitates frequent monitoring, significant load restrictions, and/or corrective actions to keep the bridge open.
1	**Bridge closed due to scour:** Channel rehabilitation may return the bridge to service.
0	**Bridge closed due to scour (beyond corrective action):** Bridge replacement is required.

2.1.13 NSTM Inspection Condition Rating (SNBI Items B.C.14)

NSTM Inspection Rating (SNBI Item B.C.14)	
Code	This item describes the condition of non-redundant steel tension members identified to be inspected using NSTM inspection procedures. The condition of the NSTMs should also be considered in the superstructure or substructure condition ratings (as applicable). This item must be reviewed and rated during all NSTM inspections. • Per the NBIS, if this item is rated 4 or lower, NSTM inspections must be conducted at intervals not to exceed 12 months. • Per the NBIS, a rating of 3 or less for this item is considered to be a critical finding.
N	**Not Applicable:** Structure has no non-redundant steel tension members.
9	**New (Initial Entry):** Condition of NSTMs has not been determined.
8	**Very Good Condition:** NSTMs have some inherent defects.
7	**Good Condition:** NSTMs have some minor defects. • Minor surface corrosion. No section loss (or section loss has been reinforced). • Cracking has been arrested. • Distortion is superficial or has been mitigated. • Connections are secure.
6	**Satisfactory Condition:** NSTMs have widespread minor or isolated moderate defects. • Extensive surface corrosion. Minor section loss, flaking rust, or pack rust. • Cracks have been arrested or pose no structural concern. • Members slightly bent, distorted, or misaligned. • Some connections distressed or loose.
5	**Fair Condition:** NSTMs have some moderate defects. Strength and performance of the NSTMs are not affected. • Moderate section loss, flaking rust, or pack rust. • Un-arrested cracks that are unlikely to propagate. • Members bent, distorted, or misaligned. • Bolts/rivets loose or missing, but connections remain intact.
4	**Poor Condition:** NSTMs have widespread moderate or isolated major defects. Strength and/or performance of an NSTM is affected. • Widespread section loss, flaking rust, or pack rust. • Significant section loss in critical stress areas. • Un-arrested cracks that could propagate into a critical stress area. • Members significantly bent or misaligned. • Connections are significantly distressed.
3	**Serious Condition:** NSTMs have major defects. Strength and/or performance of an NSTM is seriously affected. Condition typically necessitates more frequent monitoring, load restrictions, and/or corrective actions. • Severe section loss. • Un-arrested cracks in critical stress areas. • Members severely bent or misaligned. • Failed connections.
2	**Critical Condition:** NSTMs have major defects. An NSTM is severely compromised. Condition typically necessitates frequent monitoring, significant load restrictions, and/or corrective actions in order to keep the bridge open.
1	**"Imminent" Failure Condition:** Bridge is closed to traffic due to NSTM condition. Repair or rehabilitation may return the bridge to service.
0	**Failed Condition:** Bridge is closed to traffic due to NSTM condition and is beyond corrective action. Bridge replacement is required.

2.1.14 Underwater Inspection Rating (SNBI Item B.C.15)

Underwater Inspection Rating (SNBI Item B.C.15)	
This item describes the condition of submerged or partially submerged elements observed during underwater inspections. The condition of these submerged elements should also be considered in the substructure or culvert condition rating. If this item has previously been rated as part of an underwater inspection, it should be rated during periodic low water levels when underwater inspection isn't required. If long-term changes in site conditions negate the need for underwater inspections, this item would no longer need to be reported.	
Code	**Description**
N	**Not Applicable:** Underwater inspections are not required. Item B.IR.03 (Underwater Inspection Required) is coded as "N".
9	**New (Initial Entry):** Condition of submerged elements has not been determined.
8	**Very Good Condition:** Submerged elements have some inherent defects.
7	**Good Condition:** Submerged elements have some minor defects. Settlement, movement, or misalignment has been arrested or isn't a concern. • Concrete/Masonry: Minor cracking, leaching, scale, spalling (no exposed rebar), delamination, sound patches, or mortar breakdown. • Timber: Minor checking or splitting (no decay). • Steel: Minor surface corrosion. No section loss on primary members.
6	**Satisfactory Condition:** Submerged elements have widespread minor or isolated moderate defects. Minor settlement, movement, or misalignment. • Concrete/Masonry: Widespread minor scale, cracking, leaching, or mortar breakdown. Isolated moderate delamination, spall, rust staining, or misalignment. • Timber: Widespread minor checks or splits. Isolated moderate decay. • Steel: Extensive surface corrosion. Isolated flaking rust, pack rust, or section loss.
5	**Fair Condition:** Submerged elements have some moderate defects. Strength and performance are not affected. Moderate settlement, movement, or misalignment. • Concrete/Masonry: Moderate delamination, scale/spall, cracking, leaching, rust staining, voided mortar, or block misalignment. • Timber: Moderate splitting, abrasion, or decay. • Steel: Moderate flaking rust, pack rust, or section loss.
4	**Poor Condition:** Submerged elements have widespread moderate or isolated major defects. Strength and/or performance is affected. Significant settlement, movement, or misalignment. • Concrete/Masonry: Widespread moderate delamination, scale/spall, cracking, leaching, rust staining, voided mortar, or misalignment. Reinforcement with significant section loss. • Timber: Widespread splitting, abrasion, or decay. Isolated decay with crushing. • Steel: Widespread flaking rust or pack rust. Significant section loss.
3	**Serious Condition:** Submerged elements have major defects. Strength and/or performance is seriously affected. Severe settlement, movement, or misalignment. • Concrete/Masonry: Severe cracking, spalling, or block misalignment. • Timber: Severe splitting, decay, or crushing. • Steel: Severe section loss.
2	**Critical Condition (Critical Finding):** Submerged elements are critically compromised or have failed. Immediate repairs are required to prevent collapse or closure.
1	**Imminent Failure Condition:** Bridge is closed to traffic due to submerged element condition. Repair or rehabilitation may return the bridge to service.
0	**Failed Condition:** Bridge is closed due to submerged element failure and is beyond corrective action (replacement required).

3. SNBI BRIDGE APPRAISAL RATINGS

The SNBI has five appraisal ratings that identify potential bridge vulnerabilities. The coding of these items typically remains static once a bridge has been initially inventoried and inspected. The coding for these items may occasionally need to be revised if there are significant changes to the site conditions.

- B.AP.01 Approach Roadway Alignment
- B.AP.02 Overtopping Likelihood
- B.AP.03 Scour Vulnerability
- B.AP.04 Scour Plan of Action
- B.AP.05 Seismic Vulnerability

SNBI Items B.AP.01 (Approach Roadway Alignment) and B.AP.02 (Overtopping Likelihood) must be determined by the inspector and entered in BrM using the guidance below.

The coding for SNBI Items B.AP.03 (Scour Vulnerability) and B.AP.04 (Scour Plan of Action) are determined by an interdisciplinary team of structural, geotechnical and hydraulic engineers.

SNBI Item B.AP.05 (Seismic Vulnerability) is coded as “N” for all bridges in South Dakota.

3.1 APPROACH ROADWAY ALIGNMENT APPRAISAL RATING (SNBI ITEM B.AP.01)

Approach Roadway Alignment Appraisal Rating (NBI Item B.AP.01)	
This item identifies bridges that do not function adequately due to the horizontal or vertical alignment of the bridge and approach roadway. This only applies to the roadway passing over the bridge or culvert (not the roadway passing below). The rating is based on the posted speed (regulatory or advisory) at the bridge compared to the posted speed limit for the highway segment that the bridge carries. The operating speed at the bridge (actual speed of most vehicles) may be used if the speed limit is not posted or known. • Do not consider speed reductions due to the bridge width or intersecting highways. • Rating should be reviewed if the approaches have been reconstructed or reconfigured. • If advisory speed limit signs are present, they should be used as the “operating speed”. • Railroad or pedestrian bridges crossing over a roadway should be coded as ″N″.	
Code	**Description**
N - NA	Not Applicable (use for railroad or pedestrian bridges).
Blank	***New Structure. An appropriate rating code should be determined.***
G- Good	The speed is no different at the bridge than the rest of the highway segment that crosses the bridge. Minor sight distance or alignment issues. Less than 5% speed reduction (less than 5 MPH on a 55 MPH roadway).
F - Fair	The speed is noticeably different at the bridge than the rest of the highway segment that crosses the bridge. Moderate sight distance or alignment issues. 5% to 20% speed reduction (5-10 MPH on a 55 MPH roadway).
P - Poor	The speed is substantially different at the bridge than the rest of the highway segment that crosses the bridge. Severe sight distance or alignment issues. More than 20% speed reduction (More than 10 MPH on a 55 MPH roadway).

3.2 OVERTOPPING LIKELIHOOD APPRAISAL RATING (SNBI ITEM B.AP.02)

Overtopping Likelihood Appraisal Rating (NBI Item B.AP.02)	
This item describes the likelihood of the bridge deck (or roadway over a culvert) being overtopped during high water events. This item does not apply to the likelihood of the waterway overtopping approach roadways. The overtopping likelihood is typically determined from historical bridge inspection or maintenance records, hydraulic studies, local residents/landowners, and/or site indicators including highwater marks on the bridge or its surroundings, debris remains on bridge upper members, etc. When coding newer bridges with limited historical inspection or maintenance information, hydraulic design information can be used to establish an overtopping likelihood. • This item cannot be coded as “N” (or left bank) for culvert structures. • Code this item as “N” for bridges that do not cross over a waterway, as indicated by the coding of SNBI B.F.01 (Feature Type).	
Code	**Description**
N	Not Applicable (bridge does not cross over a waterway).
0	Never
1	Remote - once every 100 years or less frequently
2	Very Low - once every 51 to 99 years
3	Low - once every 26 to 50 years
4	Moderate - once every 11 to 25 years
5	High - once every 3 to 10 years
6	Very High - once every 2 years or more frequently

3.3 STRUCTURE ELEMENT CONDITION RATINGS

Structure element condition ratings provide a detailed condition evaluation of the bridge by dividing the bridge into separate elements, which are then rated individually based upon the severity and extent of deterioration. This rating system was developed by the American Association of State Highway and Transportation Officials (AASHTO) and is outlined in the "AASHTO Manual for Bridge Element Inspection".

3.3.1 Introduction to Structure Element Condition Ratings

Structure element condition ratings provide input data for a Bridge Management System, which allows computer projections of deterioration rates, providing cost-effective options for bridge maintenance, rehabilitation, or replacement. Bridge Management Systems are intended to be a source of information (and qualitative backing) for engineers and managers responsible for long-range bridge improvement programs. SDDOT adopted an element-based bridge inspection format in 1998 to comply with the 1991 Inter-Modal Surface Transportation Efficiency Act (ISTEA), which mandated that all states develop and implement a Bridge Management System (BMS) by October of 1998. In 2014, the FHWA mandated that element level condition ratings (based upon the AASHTO Manual for Bridge Element Inspection) be submitted for all bridges on the National Highway System (NHS). These were implemented in the spring of 2015.

An "element" refers to structure members (beams, pier columns, decks, etc.), or any other components (railings, expansion joints, approach panels, etc.) commonly found on a bridge or structure length culvert.

General

It should be noted there can be more than one element at superstructure and substructure locations. The most common places where multiple elements are likely to occur is at abutments, bents/piers, or at node locations on a truss.

Example:

Timber Pier Cap at an Abutment

The example picture would have the following elements coded at this abutment.

- 206 – Timber Columns
- 216 – Timber Abutment – *backing planks.*
- 228 – Timber Pile – *depending on the plans and whether it is specified as a column or pile.*
- 235 – Timber Pier/Bearing Cap – *beam on top of the columns/piling.*

3.3.2 Environments

The behavior of each bridge element over time and its rate of deterioration is governed by the environment it is in. These include, weather, deicing salts, traffic, etc. Environmental effects consist of four categories and each element or part of an element is placed in one of them. The four categories are listed below:

- **Benign – *"1"* –** Neither environmental nor operating practices are likely to change the condition of the element over time.
- **Low – *"2"*–** The effect of the environment or operating practices is small on the deterioration rates of the bridge elements.
- **Moderate – *"3"* –** Changes in the condition of the elements are affected by environmental factors or operating practices.
- **Severe – *"4"* –** Environmental factors or operating practices contribute to the rapid decline in the condition of the element.

For SD bridges the general guidance is use Environment 3 for salt usage areas and Environment 2 for low or no salt usage. The following guidelines have been established by the SDDOT in assigning environments:

State Highway System & Urban Systems:

- All elements above and including the deck will be coded as *"3"*.
- Elements below an open joint will be coded as *"3"*. This includes abutments, bearings, bent caps, and girder ends (first 6 feet).
- Elements below sealed joints will be coded as *"2"*.
- Columns will always be coded as *"2"*.

Non-State Highway System
All bridges will have their elements coded as *"2"*.

Structure Element Types

AASHTO defines three basic element types:

- **National Bridge Elements (NBEs)** represent the primary structural components of a bridge or culvert (bearings and railings are also included). The condition rating language for NBE's cannot be altered, as these are intended to remain consistent across the country.
- **Bridge Maintenance Elements (BME's)** include components of the bridge such as joints, wearing surfaces, and protective coating systems that might be managed by agencies using Bridge Management Systems. The condition rating language for BME's can be altered by states to best suit their bridge management practices.
- **Agency-Developed Elements (ADEs)** are custom elements defined by an agency. They may be sub-elements of NBE's or BME's or may have no ties to the AASHTO elements. ADE's provide some flexibility for agencies to rate specific bridge components not addressed by the NBE's or BME's.

Structure elements are also classified into five groups, depending upon structural function:

- **Deck Elements** (decks, slabs, wearing surface, deck joints, railings, and approaches)
- **Superstructure Elements** (girders, beams, arches, trusses, and bearings)
- **Substructure Elements** (abutments, piles, columns, pier caps, pier walls, and footings)
- **Culvert Elements** (culvert barrels, culvert end treatments, and roadway above culvert)
- **Miscellaneous Elements** (bridge components that do not fall under the other groups)

Structure elements are also divided into six material groups:

- **Steel or Metal Elements**
- **Reinforced Concrete Elements**
- **Pre-stressed (and Post-Tensioned) Concrete Elements**
- **Timber Elements**
- **Masonry Elements**
- **Other Material Elements** (Aluminum, Plastic, Composite, Etc.)

3.3.3 Structure Element Quantities

All element quantity calculations should follow Section 3.1 of the Manual for Bridge Element Inspection (MBEI), 2nd Edition, any interim revisions, or its successor.

Structure element quantities may be expressed in three ways:

- **Square Feet (SF):** elements such as decks, slabs, wearing surfaces, and coatings are expressed in square feet (SF) quantities.
  Examples:
  - *Decks/Slabs – Out to out width x bridge length*
  - *Wearing Surfaces – Surface length x curb to curb width.*

- **Linear Feet (LF):** elements such as girders, beams, box girders, culvert barrels, deck joints, and railings are expressed in linear feet (LF) quantities.
  Examples
  - *Girders/Stringers – Σ of span lengths x number of girder lines.*
  - *Arches – Σ of span lengths x # of arch lines.*
  - *Joints – Out to out length x # of joints.*

- **Each (EA):** elements such as columns, pilings, and bearings are expressed as each (EA) quantities.
  Example – On a bridge with three bents, and three columns at each bent, the column quantity would be 9 EA.

3.3.4 Structure Element Ratings

Structure elements are all rated on a scale of 1-4. Condition state 1 is the best condition, with condition state 4 being the worst condition (this is the reverse of the NBI condition ratings).

If the severity of deterioration varies within a particular element, the element should be rated using more than one condition state. Example, on a bridge with 500 LF of beams, 250 LF could be rated as condition state 1, 150 LF could be rated as condition state 2, and 100 LF could be rated as condition state 3, and condition state 4 would be 0 LF.

Elements expressed as an “Each” (EA) quantity can also be rated using more than one condition state (but only if the total quantity is greater than one). Example, on a bridge with 9 columns, five could be rated as condition state 1, three could be rated as condition state 2, and one could be rated as condition state 3, and condition state 4 would be 0.

3.3.5 Defect Priority Rankings

The SDDOT has determined a high to low priority ranking for the defect rankings for the elements and protection systems as noted in the latest edition of the AASHTO Manual for Bridge Element Inspection and any Agency Defined Elements (ADEs) adopted by the State. For example, if 1 LF of box culvert has a spall, delamination, and crack all in the same linear foot, the worst-case defect would be rated. The priority rankings have been grouped by material types for ease of use and are as follows:

Steel / Metal Condition State Priorities			
Rank	**Defect #**	**Defect Name**	Notes
1	**1010**	**Cracking**	
2	**1020**	**Connection**	
3	**1900**	**Distortion**	
4	**1000**	**Corrosion**	
5	**4000**	**Settlement**	Case by Case
5	**6000**	**Scour**	Case by Case
5	**7000**	**Damage**	Case by Case

Steel Protective Coatings Condition State Priorities			
Rank	**Defect #**	**Defect Name**	Notes
1	**3440**	**Effectiveness**	
2	**3440**	**Peeling/Bubbling/Cracking**	
3	**3430**	**Oxide Film Degradation Color/Texture Adherence**	Weathering Steel
4	**3410**	**Chalking**	

Wearing Surface Condition State Priorities			
Rank	**Defect #**	**Defect Name**	Notes
1	**3230**	**Effectiveness**	
2	**3210**	**Delamination/Spall/Patched Area/Pothole**	
3	**3220**	**Cracking**	
4	**7000**	**Damage**	Case by Case

Reinforced/Prestressed Concrete Condition State Priorities			
Rank	**Defect #**	**Defect Name**	Notes
1	**1100**	**Exposed Prestressing**	
2	**1090**	**Exposed Rebar**	
3	**1080**	**Delamination/Spall/Patched Areas**	
4	**1110**	**Cracking**	Prestressed
4	**1130**	**Cracking**	Reinforced
5	**1120**	**Efflorescence/Rust**	
6	**1190**	**Abrasion/Wear/Scale**	
7	**1900**	**Distortion**	Prestressed Only
7	**4000**	**Settlement**	Case by Case
7	**6000**	**Scour**	Case by Case
7	**7000**	**Damage**	Case by Case

Structure Element Display (BrM Inspection Report)

Only structure elements that have been entered for a bridge will be displayed on the BrM Inspection Report. The element condition ratings from the most recent inspection, as well as those from the previous inspection(s), are displayed on the inspection report in “SF”, “LF”, or “Each” quantities. Inspection notes pertaining to each element are displayed directly below the element. It is the Team Leaders responsibility to verify that the elements and quantities displayed on the inspection report are correct.

3.3.6 SDDOT Structure Element List

This list displays all the structure elements currently being used by SDDOT. This includes AASHTO elements and elements developed by SDDOT. AASHTO elements that do not apply to bridges in South Dakota are still included in this manual.

This element list is arranged in groups based upon the structural function and material type, in the same order that they are arranged in this manual. The AASHTO element numbering systems is used for National Bridge Elements (NBE’s) and Bridge Management Elements (BME’s). Agency-Developed Elements (ADE’s) created by SDDOT are numbered starting with 800.

SDDOT Structure Element List					
#	Element Description	Type	Component	Units	Page
	Deck & Slab Elements				
12	Reinforced Concrete Deck	NBE	Deck	SF	42
865	High Performance Concrete Deck	ADE	Deck	SF	31
13	Prestressed Concrete Deck	NBE	Deck	SF	46
15	Prestressed Concrete Top Flange	NBE	Deck	SF	46
16	Reinforced Concrete Top Flange	NBE	Deck	SF	42
28	Steel Grid Deck - Open	NBE	Deck	SF	51
29	Steel Grid Deck - Concrete Filled	NBE	Deck	SF	51
30	Steel Deck – Corrugated, Orthotropic, etc.	NBE	Deck	SF	51
31	Timber Deck	NBE	Deck	SF	48
38	Reinforced Concrete Slab	NBE	Deck	SF	42
866	High Performance Concrete Slab	ADE	Deck	SF	31
54	Timber Slab	NBE	Deck	SF	48
60	Other Material Deck	NBE	Deck	SF	43
65	Other Material Slab	NBE	Deck	SF	43
	Wearing Surface Elements/Protection Systems				
510	Wearing Surface	BME	Deck	SF	45
809	Gravel Wearing Surface	ADE	Deck	SF	52
810	Low Slump Dense Concrete (LSDC) overlay	ADE	Deck	SF	46
811	Latex Modified Concrete (LMC) overlay	ADE	Deck	SF	46
812	Epoxy/Polymer Chip Seal (ECS/PCS) overlay	ADE	Deck	SF	50
813	Asphalt Concrete w/ Membrane overlay	ADE	Deck	SF	49
814	Asphalt Concrete w/o Membrane overlay	ADE	Deck	SF	49
830	Timber Running Planks	ADE	Deck	SF	51
831	Rubberized Asphalt Chip Seal (RACs) overlay	ADE	Deck	SF	49
832	Fiber Concrete Overlay	ADE	Deck	SF	46
833	Concrete Overlay (A40 or A45)	ADE	Deck	SF	46
	Concrete Reinforcing Steel Protective System Elements				
520	Concrete Reinforcing Steel Protective System	BME	Miscellaneous	SF	64
820	Epoxy Coated Resteel	ADE	Miscellaneous	SF	64
821	Stainless Resteel	ADE	Miscellaneous	SF	64
822	Zinc and Epoxy Resteel	ADE	Miscellaneous	SF	64

SDDOT Structure Element List					
#	Element Description	Type	Component	Units	Page
	Concrete Protective System Elements				
521	Concrete Protective Coating	BME	Deck	SF	64
825	Silanes/Siloxanes	ADE	Deck	SF	53
826	Methacrylates	ADE	Deck	SF	53
827	Silicates	ADE	Deck	SF	53
	Deck Joint Elements				
300	Strip Seal Expansion Joint	BME	Deck/Approach	LF	66
301	Poured Joint Seal	BME	Deck/Approach	LF	68
302	Compression Joint Seal	BME	Deck/Approach	LF	70
303	Assembly Joint with Seal (Modular)	BME	Deck/Approach	LF	72
304	Open Expansion Joint	BME	Deck/Approach	LF	74
305	Assembly Joint without Seal	BME	Deck/Approach	LF	76
306	Other Joint	BME	Deck/Approach	LF	54
	Bridge Railing Elements				
330	Metal Bridge Railing	NBE	Deck	LF	79
331	Reinforced Concrete Bridge Railing	NBE	Deck	LF	81
332	Timber Bridge Railing	NBE	Deck	LF	85
333	Other Material Bridge Railing	NBE	Deck	LF	87
334	Masonry Bridge Railing	NBE	Deck	LF	88
	Bridge Approach Roadway Elements				
320	Prestressed Concrete Approach Slab	BME	Approach	SF	90
321	Reinforced Concrete Approach Slab	BME	Approach	SF	90
870	Asphalt Concrete Approaches	ADE	Approach	SF	93
872	Gravel Approaches	ADE	Approach	SF	93
873	Sidewalk Approaches	ADE	Approach	SF	79
875	Approach Smoothness Near Beginning of Bridge	ADE	Approach	EA	84
876	Approach Smoothness Near End of Bridge	ADE	Approach	EA	84
	Steel Superstructure Elements				
102	Steel Closed Web/Box Girder	NBE	Superstructure	LF	87
107	Steel Open Girder or Beam	NBE	Superstructure	LF	87
113	Steel Stringer	NBE	Superstructure	LF	87
120	Steel Truss	NBE	Superstructure	LF	87
141	Steel Arch	NBE	Superstructure	LF	87
147	Steel Cable – Primary	NBE	Superstructure	LF	139
148	Steel Cable – Secondary	NBE	Superstructure	Each	140
152	Steel Floor Beam	NBE	Superstructure	LF	87
161	Pin, Pin & Hanger Assembly, or Both	NBE	Superstructure	Each	136
162	Steel Gusset Plate	NBE	Superstructure	Each	87
	Steel Substructure Elements				
202	Steel Column	NBE	Substructure	Each	92
207	Steel Column Tower (Trestle)	NBE	Substructure	LF	101
219	Steel Abutment	NBE	Substructure	LF	101
225	Steel Piling	NBE	Substructure	Each	92
231	Steel Pier Cap	NBE	Substructure	LF	101
	Steel Protective Coating				
515	Steel Protective Coating	BME	Miscellaneous	SF	95
815	Weathering Steel Coating	ADE	Miscellaneous	SF	95
816	Lead Based Coating	ADE	Miscellaneous	SF	95
817	Non-Lead Based Coating	ADE	Miscellaneous	SF	95
818	Metallized/Galvanized Coating	ADE	Miscellaneous	SF	95

SDDOT Structure Element List					
#	Element Description	Type	Component	Units	Page
	Reinforced Concrete Superstructure Elements				
105	Reinforced Concrete Closed Web/Box Girder	NBE	Superstructure	LF	110
110	Reinforced Concrete Open Girder or Beam	NBE	Superstructure	LF	110
116	Reinforced Concrete Stringer	NBE	Superstructure	LF	110
144	Reinforced Concrete Arch	NBE	Superstructure	LF	110
155	Reinforced Concrete Floor Beam	NBE	Superstructure	LF	110
	Reinforced Concrete Substructure Elements				
205	Reinforced Concrete Column	NBE	Substructure	Each	104
210	Reinforced Concrete Pier Wall	NBE	Substructure	LF	113
215	Reinforced Concrete Abutment	NBE	Substructure	LF	113
220	Reinforced Concrete Pile Cap/Footing	NBE	Substructure	LF	113
227	Reinforced Concrete Piling	NBE	Substructure	Each	104
234	Reinforced Concrete Pier/Bent Cap	NBE	Substructure	LF	113
	Prestressed Concrete Superstructure Elements				
104	Prestressed Concrete Closed Web/Box Girder	NBE	Superstructure	LF	119
109	Prestressed Concrete Open Girder or Beam	NBE	Superstructure	LF	119
115	Prestressed Concrete Stringer	NBE	Superstructure	LF	119
143	Prestressed Concrete Arch	NBE	Superstructure	LF	119
154	Prestressed Concrete Floor Beam	NBE	Superstructure	LF	119
	Prestressed Concrete Substructure Elements				
204	Prestressed Concrete Column	NBE	Substructure	Each	122
226	Prestressed Concrete Piling	NBE	Substructure	Each	122
233	Prestressed Concrete Pier/Bent Cap	NBE	Substructure	LF	122
	Timber Superstructure Elements				
111	Timber Girder or Beam	NBE	Superstructure	LF	124
117	Timber Stringer	NBE	Superstructure	LF	124
135	Timber Truss	NBE	Superstructure	LF	124
146	Timber Arch	NBE	Superstructure	LF	124
156	Timber Floor Beam	NBE	Superstructure	LF	124
	Timber Substructure Elements				
206	Timber Column	NBE	Substructure	Each	127
208	Timber Column Tower (Trestle)	NBE	Substructure	LF	127
212	Timber Pier Wall	NBE	Substructure	LF	127
216	Timber Abutment	NBE	Substructure	LF	127
228	Timber Piling	NBE	Substructure	Each	127
235	Timber Pier/Bent Cap	NBE	Substructure	LF	127
	Masonry Superstructure & Substructure Elements				
145	Masonry Arch	NBE	Superstructure	LF	130
213	Masonry Pier Wall	NBE	Substructure	LF	130
217	Masonry Abutment	NBE	Substructure	LF	130
	Bearings Elements				
310	Elastomeric Bearing	NBE	Superstructure	Each	136
311	Moveable (Roller, Sliding, Rocker, etc.) Bearing	NBE	Superstructure	Each	139
312	Enclosed/Concealed Bearing	NBE	Superstructure	Each	122
313	Fixed Bearing	NBE	Superstructure	Each	142
314	Pot Bearing	NBE	Superstructure	Each	144
315	Disk Bearing	NBE	Superstructure	Each	144
316	Other Bearing	NBE	Superstructure	Each	122

SDDOT Structure Element List					
#	Element Description	Type	Component	Units	Page
	Culvert Elements				
240	Culvert – Steel	NBE	Culvert	LF	156
241	Culvert – Reinforced Concrete	NBE	Culvert	LF	149
242	Culvert – Timber	NBE	Culvert	LF	166
243	Culvert – Other Material	NBE	Culvert	LF	157
244	Culvert – Masonry	NBE	Culvert	LF	170
245	Culvert – Prestressed Concrete	NBE	Culvert	LF	149
841	Culvert – Precast Concrete	ADE	Culvert	LF	149
842	Culvert Wingwall	ADE	Culvert	EA	163
843	Culvert Apron	ADE	Culvert	EA	163
871	Roadway Over Culvert	ADE	Culvert	Each	161
	Other Elements				
880	Utilities	ADE	Miscellaneous	Each	165

3.4 CRITICAL FINDINGS AND SAFETY HAZARDS

3.4.1 Critical Findings or Safety Hazards

The SDDOT has a procedure in place with required forms that must be followed for identification and documentation of critical findings. See Appendix C of this manual.

3.5 DECK AND SLAB ELEMENTS

3.5.1 Rating Procedures for Decks and Slabs

Most typical decks or slabs will be rated using two structure elements. The underside is rated using one of the deck or slab elements, and the top is rated using Element #510 (Wearing Surface) or the correct Agency Defined Element (ADE).

The square feet (SF) quantity should include the full width of the deck (out-to-out dimension) over the length of the bridge. If segments of a bridge deck are comprised of different material types, more than one deck (or slab) element should be used. If the roadway and sidewalk decks are comprised of different materials, they should be rated under separate deck (or slab) elements.

The SF quantities may be broken up into multiple conditions states. In most situations, the deck (or slab) element rating will be based upon the underside condition. In this manual, the condition rating descriptions for deck and slab elements are divided into five material groups:

- **Concrete Decks & Slabs** (Elements #12, #16, #38, #865, and #866)
- **Prestressed Concrete Decks & Slabs** (Elements #13 and #15)
- **Timber Decks & Slabs** (Elements #31 and #54)
- **Steel Decks** (Elements #28, #29, and #30)
- **Other Material Decks & Slabs** (Elements #60 and #65)

Most bridge decks in South Dakota consist of reinforced concrete. Most concrete bridge decks constructed in South Dakota on state highways since approximately 1980 have epoxy coated reinforcement. The SDDOT has switched over to stainless-steel reinforcement for DOT-owned structures around 2023.

Element #510 is used to rate the top surface on bridge decks or slabs with any wearing surface type or material or the appropriate ADE should be used. This element or any wearing surface ADEs do not apply to bridges with the decks or slabs placed in one monolithic concrete pour.

- On roadway bridges, the SF wearing surface quantity includes only the roadway surface area (curb to curb). Sidewalks, curbs, and raised medians are excluded.
- On pedestrian bridges, the SF wearing surface quantity includes the entire top deck surface area (curb-to-curb or rail-to-rail).
- For bridge decks that carry only rail traffic, Element #510 does not have to be rated. There is no need for a roadway agency to inspect the top of the deck on an active railroad. An appropriate deck element should be selected and rated (based upon the underside condition). The inspection report notes should indicate if the railroad is active and how many tracks are present.

Element #521 (Concrete Protective Coating) is intended only for concrete bridge decks that have been “sealed” with a waterproof sealant or the appropriate ADE should be used.

3.5.2 Reinforced Concrete Decks & Slabs (Elements #12, #16, #38, #865, and #866)

Reinforced Concrete Deck & Slab Elements				
#12: Reinforced Concrete Deck (SF) **#16: Reinforced Concrete Top Flange (SF)** **#38: Reinforced Concrete Slab (SF)**			**#865: High Performance Concrete Deck (SF)** **#866: High Performance Concrete Slab (SF)**	
These elements describe the condition of reinforced concrete decks or slabs. The deck overhangs and vertical fascia edges should also be considered in this rating. The top surface of the deck or slab is rated using the appropriate wearing surface element. • Element #16 (Reinforced Concrete Top Flange) refers to the upper horizontal "flange" of box girders, cast-in-place concrete T-girders, or precast concrete channel or double-T beams.				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Delamination, Spall, Patched Area (1080)	None	Delamination (not yet loose). Spall 1" or less deep **and** 6" or less in diameter. Repaired area is sound.	Loose delamination. Spall more than 1" deep **or** more than 6" diameter. Repaired area is unsound or distressed.	Loose delamination (safety hazard). Spalling greater than 3" deep. Full-depth failures present or imminent.
Exposed Reinforcement (1090)	None	Exposed rebar without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Efflorescence, Water/Salt Saturation, Rust Staining or Leaching (1120)	None	Light leaching (little or no build-up) or light water saturation.	Heavy leaching (significant build-up or stalactites). Significant water/salt saturation. Rust stains indicating rebar corrosion.	Severe leaching or severe salt/water saturation (deck failure imminent).
Cracking and Pattern/Map Cracking (1130)	Insignificant cracks (less than 0.012") or moderate width cracks that have been sealed.	Unsealed moderate (0.012" to 0.05") width cracks. Unsealed moderate density pattern/map (spacing of greater than 1' to 3' on center) with moderate width cracking.	Wide (greater than 0.05" to 0.125") cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1' or less on center).	Severe (greater than 0.125") cracks or full depth fractures. Deck failure may be imminent.
Scale, Abrasion, or Wear (1190)	Superficial.	Coarse aggregate is exposed (½" deep or less) but remains secure in the concrete matrix.	Coarse aggregate is loose (greater than ½" to 3") or popped out of the concrete matrix.	Severe voiding (greater than 3") or concrete is unsound.
Damage (7000)	None.	Minor to moderate impact damage. Impact captured in condition state 2 under the appropriate defect.	Significant impact damage. Impact captured in condition state 3 under the appropriate defect.	Severe impact damage. Impact captured in condition state 4 under the appropriate defect.
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1' wide for ease of calculations and consistency. • As a general rule, pattern or map cracked areas or areas with concentrated cracking can be documented and rated as a square foot (SF) area.				

Reinforced Concrete Deck & Slab Elements	
#12: Reinforced Concrete Deck (SF) **#16: Reinforced Concrete Top Flange (SF)** **#38: Reinforced Concrete Slab (SF)**	**#865: High Performance Concrete Deck (SF)** **#866: High Performance Concrete Slab (SF)**
Condition Rating Examples (Reinforced Concrete Decks & Slabs)	
 **Condition State 2** **Transverse crack on the underside of a concrete deck with light leaching (efflorescence)**	 **Condition State 2** **Diagonal crack on the underside of a concrete deck with light leaching (efflorescence)**
 **Condition State 2** **Map cracking (moderate width) on the underside of a deck with no leaching or water saturation**	 **Condition State 2** **Light water saturation on the underside of a concrete deck**

Reinforced Concrete Deck & Slab Elements	
#12: Reinforced Concrete Deck (SF) **#16: Reinforced Concrete Top Flange (SF)** **#38: Reinforced Concrete Slab (SF)**	**#865: High Performance Concrete Deck (SF)** **#866: High Performance Concrete Slab (SF)**
 **Condition State 3** **Map cracking with heavy leaching on the underside of a concrete deck**	 **Condition State 3** **Heavy leaching on the underside of a deck (not over traffic)**
 **Condition State 3** **Significant water saturation and rust staining on the underside of a concrete deck**	 **Condition State 3** **Spalling (deeper than 1") with exposed and corroded rebar on the underside of a concrete deck**

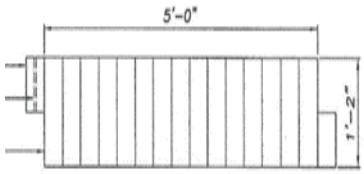
Reinforced Concrete Deck & Slab Elements	
#12: Reinforced Concrete Deck (SF) **#16: Reinforced Concrete Top Flange (SF)** **#38: Reinforced Concrete Slab (SF)**	**#865: High Performance Concrete Deck (SF)** **#866: High Performance Concrete Slab (SF)**
 **Condition State 4** **Severe spalling (more than 3” deep) on the underside of a concrete deck**	 **Condition State 4** **Delaminated and loose concrete on the underside of a concrete deck (over traffic - safety hazard)**

3.5.3 Prestressed Concrete Decks and Slabs (Elements #13 and #15)

Prestressed Concrete Deck & Slab Elements				
#13: Prestressed Concrete Deck (SF) **#15: Prestressed Concrete Top Flange (SF)**				
These elements describe the underside condition of prestressed (or post-tensioned) concrete decks or slabs. The deck overhangs and vertical fascia edges should also be considered in this rating. The top surface of the deck or slab is rated using the appropriate wearing surface element. • Element #15 (Prestressed Concrete Top Flange) refers to the upper horizontal "flange" of prestressed box girders or prestressed Bulb, Double, or Quad Tees.				
Defects	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review, Repairs, or Underpinning	No deck repairs present.	Repaired area that is sound.	Repaired area that is unsound or showing distress. Structural underpinning in fair to poor condition.	Immediate repairs or structural review required. Full-depth failures present or imminent.
Delamination, Spall, Patched Area (1080)	None	Delamination (not yet loose). Spalling 1" or less deep **and** 6" or less in diameter.	Loose delamination. Spalling greater than 1" deep **or** greater than 6" diameter.	Loose delamination (safety hazard). Spalling deeper than 3".
Exposed Rebar (1090)	None.	Exposed without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Exposed Prestressing Strands (1100)	None	Exposed without section loss.	Exposed with corrosion or section loss (not severed).	Exposed with severe section loss (or severed).
Cracking and Pattern/Map Cracking (1110)	Insignificant cracks (less than 0.004") or moderate width cracks that have been sealed.	Unsealed moderate (0.004" to 0.009") width cracks. Unsealed moderate density pattern/map (spacing of greater than 1' to 3' on center) with moderate width cracking.	Wide (greater than 0.009" to 0.02") cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1' or less on center).	Severe (greater than 0.125") cracks or full depth fractures. Deck failure may be imminent.
Efflorescence, Water/Salt Saturation, Rust Staining or Leaching (1120)	None	Light leaching (little or no build-up) or light water saturation.	Heavy leaching (significant build-up or stalactites). Significant water/salt saturation. Rust stains indicating rebar corrosion.	Severe leaching or severe salt/water saturation (deck failure imminent).
Scale, Abrasion, or Wear (1190)	Superficial.	Coarse aggregate is exposed (½" deep or less) but remains secure in the concrete matrix.	Coarse aggregate is loose (greater than ½" to 3") or popped out of the concrete matrix.	Severe voiding (greater than 3") or concrete is unsound.
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1' wide for ease of calculations and consistency. • As a general rule, pattern or map cracked areas or areas with concentrated cracking can be documented and rated as a SF area.				

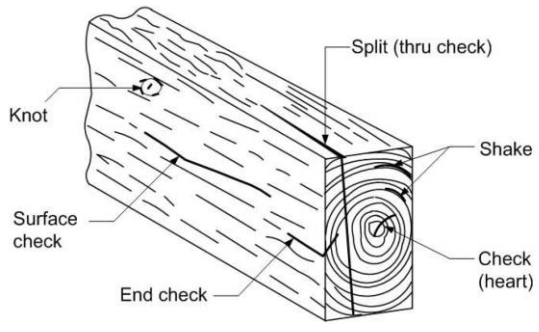
Prestressed Concrete Deck & Slab Elements	
#13: Prestressed Concrete Deck (SF)	#15: Prestressed Concrete Top Flange (SF)
Condition Rating Examples (Prestressed Concrete Decks & Slabs)	
 **Condition State 2** **Light leaching along joint between prestressed voided slab panels**	 **Condition State 2** **Minor spalling (no exposed steel) along the edge of a prestressed voided slab panel**
 **Condition State 3** **Cracking with heavy leaching on the underside of a prestressed voided slab panel**	 **Condition State 4** **Loose delamination (over traffic) on the underside of prestressed voided slab panel**

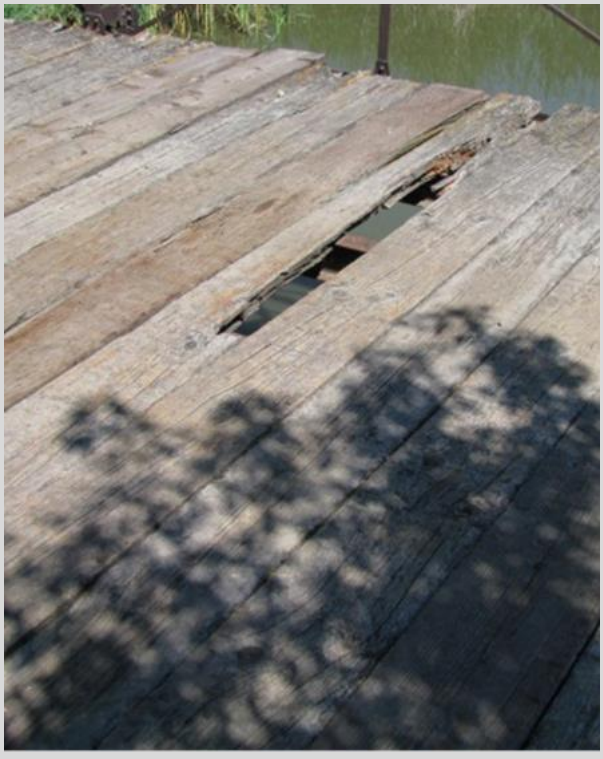
3.5.4 Timber Decks and Slabs (Elements #31 and #54)

Timber Deck & Slab Elements	
#31: Timber Deck (SF)	**#54: Timber Slab (SF)**
These elements describe the condition of timber decks (or slabs). This includes timber plank decks, glue-lam timber deck panels, and nail laminated timber decks or slabs. The rating will typically reflect the underside condition but should also consider the top condition on bare timber decks or slabs. If a wearing surface (bituminous overlay, gravel, timber wearing planks, or other material) is present, Element #510 (Wearing Surface) or another applicable element must also be rated.	
	**Timber Plank Decks** Plank decks are comprised of transverse timber planks (wide dimension in the horizontal plane). The planks are typically clipped to the top flange of steel beams and nailed (or bolted) to timber beams. Timber plank decks are found primarily on low-volume roads or pedestrian bridges. Timber plank decks are typically bare (no overlay), but longitudinal wearing planks are sometimes present along the wheel tracks.
	**Nail-Laminated Timber Decks** Nail-laminated timber decks consist of transverse timbers (wide dimension in the vertical position) that are nailed to the adjacent timbers. These are often installed in pre-nailed sections, with overlap joints between adjacent sections. Nail-laminated decks may have a bituminous overlay, longitudinal timber wearing planks, or a gravel wearing surface.
	**Glulam Timber Decks** Glulam decks are similar to nail-laminated decks, except the individual timbers are bonded together with waterproof structural adhesive. The panels are typically around 4 ft. wide and are installed transversely across the deck. Glulam timber decks are often used on temporary bridges (with a bituminous overlay). When used in new construction, they may have timber wearing planks.
  **Timber Slab Panel Cross Section**	**Timber Slabs** Timber slabs are comprised of adjacent timber planks set vertically – the timbers run longitudinally and serve as the primary superstructure element (as well as the deck). Most timber slabs are nail-laminated, newer timber slabs may be glulam or stress-laminated. Timber slabs are typically comprised of prefabricated panels – there will often be a transverse beam running below the slab at the center of each span – these help to tie the panels together and distribute load and deflection across the width of the slab. Transverse beams below timber slabs should be rated using Element #156 (Timber Floor Beam). Timber slabs often have a bituminous or gravel wearing surface.

Timber Deck & Slab Elements				
#31: Timber Deck (SF) / #54: Timber Slab (SF)				
Defects	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** structural review has determined that the defects impact strength or serviceability.
Connection or Misalignment (1020)	Components are properly aligned and securely connected.	Loose fasteners or slight misalignment of components.	Fasteners broken or missing. Components loose or misaligned.	Components severely misaligned or missing.
Repairs	No repairs are present.	Existing repair in sound condition.	Repairs are recommended **or** existing repair is deteriorated.	Immediate repairs are required (failures present or imminent).
Section Loss (1140)	None	Less than 10% of the deck or slab thickness.	Affects 10% or more of the deck or slab thickness.	More than 10% of the deck or slab thickness & warrants review.
Decay (1140)	No evidence of decay.	Staining. No crushing or sagging.	Minor crushing or sagging.	Significant crushing or sagging.
Shakes, Checks, or Splits (1150)	Less than 5% of the member thickness.	5% to 50% of the member thickness and not in a tension zone.	More than 50% of the thickness (or more than 5% of the member thickness in a tension zone).	Split through entire member (or more than 25% of the member thickness in a tension zone).
Fire Damage	None	Soot or superficial charring.	Significant charring.	Severe charring.
Split or Delamination (1170)	None	Minor	Significant	Severe
Weathering, Abrasion, or Section Loss (1180)	Minor surface deterioration (no section loss).	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness.	More than 10% of the member thickness & warrants review.

- **Shake:** A separation along the grain (between the growth rings). Usually forms within a standing tree or during felling.
- **Check:** A separation perpendicular to the grain (across the growth rings). Usually results from stress due to drying shrinkage.
- **Split (or Thru Check):** A check extending further through the timber member due to tearing apart of wood cells.



Timber Deck & Slab Elements	
#31: Timber Deck (SF)	#54: Timber Slab (SF)
Condition Rating Examples (Timber Decks & Slabs)	
 **Condition State 2** Weathering (minor section loss) on a timber plank.	 **Condition State 2** Staining on the underside of a timber slab.
 **Condition State 3** Fire damage (significant charring) on a timber slab.	 **Condition State 4** Hole in a timber plank deck.

3.5.5 Steel Decks (Elements #28, #29, and #30)

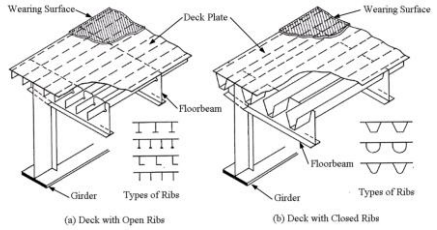
Steel Grid Deck Elements				
#28: Steel Grid Deck – Open (SF)		#29: Steel Grid Deck – Concrete Filled (SF)		
These elements describe the condition of steel grid decks. Note: The rating should consider any deck support components that are not addressed by other structural elements.				
		**Open Grid Steel Decks (Element #28)** Open grid steel grid panels may be welded, riveted, or bolted. Note: A wearing surface element does not need to be rated for open grid decks.		
		**Concrete-Filled Steel Grid Decks (Element #29)** Use this element for steel grid decks that are fully or partially filled with concrete. Note: A wearing surface element would only apply to the filled section of the deck.		
Defects	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review or Repairs	No deck repairs present.	Repaired area that is sound.	Repaired area that is showing distress. Repairs may be recommended (structural review is not required) **or** structural review has determined that the strength of the deck has not been impacted.	Immediate repairs or structural review are required. Full-depth failures may be present or imminent **or** structural review has determined that the defects impact the strength of the deck.
Corrosion (1000)	None	Surface corrosion (freckled rust).	Section loss or pack rust is present.	Severe section loss (holes rusted through).
Cracking (1010)	None	Crack has self-arrested or has been arrested or repaired.	Crack that has not been arrested but is unlikely to propagate.	Crack through deck panel (or support beam) that warrants immediate repair.
Connection or Misalignment (1020)	Deck panels are properly aligned and securely connected.	Loose fasteners or slightly misaligned deck panels.	Broken or missing fasteners. Deck panels loose or misaligned.	Steel grid deck panels severely misaligned or missing.
Impact Damage (7000) or Distortion (1900)	Superficial damage (minor scrapes).	Deck components slightly bent or bowed.	Deck components bent, bowed, loosened, or misaligned.	Severely bent, bowed, torn loose or missing.

Steel Decks

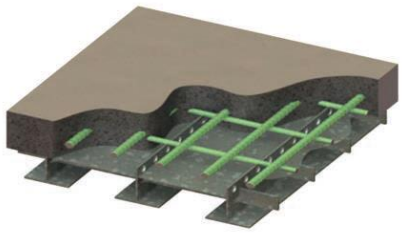
#30: Steel Decks – Corrugated/Orthotropic/Etc. (SF)

This element should be used to describe the underside condition of corrugated steel decks, orthotropic steel plate decks, exodermic decks, steel ballast plate decks, or any type of steel deck that cannot be adequately described using elements #28 or #29. The top surface of the deck or slab is rated using the appropriate wearing surface element.
Note: The rating should take into consideration any deck support components that are not addressed by other structural elements.

Corrugated Steel Decks
Corrugated decks are comprised of corrugated steel forms (with concrete or bituminous fill). The steel forms provide the primary structural support for the completed deck.



Orthotropic Steel Plate Decks
An orthotropic deck consists of a steel plate that has been stiffened by closely spaced ribs. An orthotropic deck typically acts integrally with the superstructure.



Exodermic Decks
An Exodermic deck is a recently developed composite design that combines a steel grid deck with a reinforced concrete deck (advantages include light weight and rapid construction).

Steel Ballast Plate Decks
These decks are common on railroad bridges. They typically consist of a solid steel plate, covered with a waterproof membrane, rock ballast, and railroad ties and tracks.

Steel ballast plates are typically connected to the top flange of the supporting beams with small clips - these clips sometimes have a small chain to prevent them from falling onto traffic if they come loose.

The inspector should note if the railroad tracks are active or if the tracks have been removed.
Railroad bridges converted to trail use may have a concrete, bituminous, or gravel wearing surface – Element #510 (Wearing Surface) should be rated.

Steel Decks				
#30: Steel Deck – Corrugated/Orthotropic/Etc. (SF)				
Defects	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review or Repairs	No deck repairs present.	Repaired area that is sound.	Repaired area that is showing distress. Repairs may be recommended (structural review is not required) **or** structural review has determined that the strength of the deck has not been impacted.	Immediate repairs or structural review are required. Full-depth failures may be present or imminent **or** structural review has determined that the defects impact the strength of the deck.
Corrosion (1000)	None	Surface corrosion (freckled rust).	Section loss or pack rust is present.	Severe section loss (holes rusted through).
Cracking (1010)	None	Crack has self-arrested or has been arrested or repaired.	Crack that has not been arrested but is unlikely to propagate.	Crack through deck panel (or support beam) that warrants immediate repair.
Connection or Misalignment (1020)	Primary deck components are properly aligned and securely connected.	Some loose fasteners, but primary deck components are still secure.	Some fasteners broken or missing. Primary deck components may be loose or misaligned.	Primary deck components may be severely misaligned or missing.
Impact Damage (7000) or Distortion (1900)	Superficial damage (minor scrapes).	Deck components slightly bent, bowed, or misaligned.	Deck components significantly bent, bowed, or misaligned.	Deck components severely damaged (bent, bowed, or missing).

Condition Rating Examples (Other Steel Decks)

Condition State 2
Paint failure and surface corrosion on the underside of a wrought iron ballast plate deck

Condition State 4
Hole rusted through a steel ballast plate deck (crack extending out of rust hole)

3.5.6 Other Materials Decks & Slabs (Elements #60 and #65)

Other Materials Deck & Slab Elements				
#60: Other Material Deck (SF)			**#65: Other Material Slab (SF)**	
These elements describe the condition of other material type decks or slabs not noted earlier in this Manual. The deck overhangs and vertical fascia edges should also be considered in this rating. The top surface of the deck or slab is rated using the appropriate wearing surface element if applicable.				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Corrosion (1000)	None	Surface corrosion (freckled rust).	Section loss or pack rust is present.	Severe section loss (holes rusted through).
Cracking (1010)	None	Crack has self-arrested or has been arrested or repaired.	Crack that has not been arrested but is unlikely to propagate.	Crack through deck panel (or support beam) that warrants immediate repair.
Connection or Misalignment (1020)	Primary deck components are properly aligned and securely connected.	Some loose fasteners, but primary deck components are still secure.	Some fasteners broken or missing. Primary deck components may be loose or misaligned.	Primary deck components may be severely misaligned or missing.
Delamination, Spall, Patched Area (1080)	None	Delamination (not yet loose). Spall 1” or less deep **and** 6” or less in diameter. Repaired area is sound.	Loose delamination. Spall more than 1” deep **or** more than 6” diameter. Repaired area is unsound or distressed.	Loose delamination (safety hazard). Spalling greater than 3” deep. Full-depth failures present or imminent.
Efflorescence, Water/Salt Saturation, Rust Staining or Leaching (1120)	None	Light leaching (little or no build-up) or light water saturation.	Heavy leaching (significant build-up or stalactites). Significant water/salt saturation. Rust stains indicating rebar corrosion.	Severe leaching or severe salt/water saturation (deck failure imminent).
Cracking and Pattern/Map Cracking (1130)	Insignificant cracks (less than 0.012”) or moderate width cracks that have been sealed.	Unsealed moderate (0.012” to 0.05”) width cracks. Unsealed moderate pattern/map (spacing of greater than 1’ to 3’ on center) with moderate width cracking.	Wide (greater than 0.05” to 0.125”) cracks. Heavy pattern/map with unsealed moderate width cracking or greater (spacing of 1’ or less on center).	Severe (greater than 0.125”) cracks or full depth fractures. Deck failure may be imminent.
Distortion (1900)	Superficial damage (minor scrapes).	Deck components slightly bent, bowed, or misaligned.	Deck components significantly bent, bowed, or misaligned.	Deck components severely damaged (bent, bowed, or missing).
Damage (7000)	None.	Minor to moderate impact damage. Impact captured in condition state 2 under the appropriate defect.	Significant impact damage. Impact captured in condition state 3 under the appropriate defect.	Severe impact damage. Impact captured in condition state 4 under the appropriate defect.

Other Materials Deck & Slab Elements				
#60: Other Material Deck (SF) #65: Other Material Slab (SF)				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review or Repairs	No deck repairs present.	Repaired area that is sound.	Repaired area that is showing distress. Repairs may be recommended (structural review is not required) **or** structural review has determined that the strength of the deck has not been impacted.	Immediate repairs or structural review are required. Full-depth failures may be present or imminent **or** structural review has determined that the defects impact the strength of the deck.
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1' wide for ease of calculations and consistency. • As a general rule, pattern or map cracked areas or areas with concentrated cracking can be documented and rated as a SF area.				

3.5.7 Wearing Surface Elements

#510: Wearing Surface (SF)				
For bridges with a deck or slab element, this element is typically used to rate the condition of the top wearing surface. This element does not apply to bridges with the decks or slabs placed in one monolithic concrete pour. This table includes specific condition rating criteria for low slump concrete, bituminous, epoxy chip seal, timber plank, or gravel wearing surfaces. For other deck wearing surfaces, use the "General" condition guidelines. This element does not need to be rated for bare timber decks, open grid steel decks, or decks carrying only rail traffic.				
General Guidelines (All Wearing Surface Types)				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
General Condition	Little or no deterioration.	Minor to moderate deterioration (no repairs needed).	Significant deterioration (repairs recommended).	Severe deterioration (repairs required).
Delamination, Spall, Patched Area, Pothole (3210)	None.	Delaminated. Spalling 1" or less deep **and** 6" or less in diameter. Patched area that is sound. Partial-depth pothole.	Spalling greater than 1" deep **or** greater than 6" diameter. Patched area that is unsound or showing distress. Full-depth pothole.	The wearing surface is no longer effective.
Cracking (3220)	Insignificant cracks (less than 0.012") or moderate width cracks that have been sealed.	Unsealed moderate (0.012" to 0.05") width cracks. Unsealed moderate density pattern/map (spacing of greater than 1' to 3' on center) with moderate width cracking.	Wide (greater than 0.05" to 0.125") cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1' or less on center).	Severe (greater than 0.125") cracks or full depth fractures. Deck failure may be imminent.
Effectiveness (3230)	Fully effective. No evidence of leaking or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	The wearing surface is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in condition state 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in condition state 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in condition state 4 under the appropriate material defect entry.

3.5.8 Concrete Wearing Surfaces (Elements #510, #810, #811, #832, and #833)

#510: Wearing Surface – Concrete (SF)
#810: Low Slump Dense Concrete (LSDC) Overlay (SF)
#811: Latex Modified Concrete (LMC) Overlay (SF)
#832: Fiber Reinforced Concrete Overlay (SF)
#833: A40/A45 Concrete Overlay (SF)

Low slump dense concrete (LSDC) overlays are one of the most common wearing surfaces on concrete bridge decks in South Dakota. Low slump overlays are intended to provide a high-density surface to protect the underlying deck from chlorides. This is typically a 2" thick layer of concrete with a high cement content, small coarse aggregate, and a 1" slump. Low slump concrete is mixed at the bridge site and is bonded to the deck with a grout layer. The other overlay types shown are also found on South Dakota bridge decks. Most are placed in a similar manner as a LSDC overlay, provided a new driving surface, and protect the underlying deck from chlorides.

Element #510 should be used for concrete wearing surfaces that do not fit the DOT's ADEs.

Item or Defect	Structural Element Condition States			
	1 Good	2 Fair	3 Poor	4 Severe
Delamination, Spall, Patched Area (3210)	None	Delaminated. Spall 1" or less deep **and** 6" or less in diameter. Permanent patches (concrete or another high-quality repair) that remains sound.	Spall more than 1" deep **or** more than 6" diameter. Repaired area is unsound or distressed or bituminous or other temporary patches.	Loose delamination (safety hazard). Spalling greater than 2" deep. Loose overlay sections. Patches that have failed.
Scale, Wear, or Abrasion (Use 3230)	None.	Up to ½" deep.	From ½" up to 1½" deep.	Greater than 1½" deep.
Cracking (3220)	Insignificant cracks (less than 0.012") or moderate width cracks that have been sealed.	Unsealed moderate (0.012" to 0.05") width cracks. Unsealed moderate density pattern/map (spacing of greater than 1' to 3' on center) with moderate width cracking.	Wide (greater than 0.05" to 0.125") cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1' or less on center).	Severe (greater than 0.125") cracks or full depth fractures. Deck failure may be imminent.
Effectiveness (3230)	Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	The wearing surface is no longer effective.

- Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1' wide for ease of calculations and consistency.
- As a general rule, pattern or map cracked areas or areas with concentrated cracking can be documented and rated as a SF area.
- Effectiveness is typically used as a catch-all. Use the condition state notes for the defect in question and rate accordingly. See the scale/abrasion example provided.

#510: Wearing Surface – Concrete (SF)
#810: Low Slump Dense Concrete (LSDC) Overlay (SF)
#811: Latex Modified Concrete (LMC) Overlay (SF)
#832: Fiber Concrete Overlay (SF)
#833: Concrete Overlay (A40 or A45) Overlay (SF)

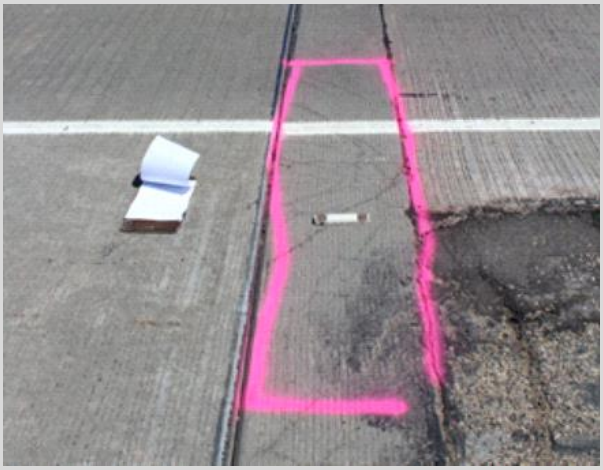
Condition Rating Examples (Concrete Overlays)

Condition State 2
Map cracking (1/32″ or 0.03″ wide) on a low slump concrete overlay

Condition State 2
Sealed cracks (medium width) on a reinforced concrete bridge deck

Condition State 2
Sound concrete patch on a low slump overlay

Condition State 2
Scaling (1/4″ deep) on a low slump overlay



Condition State 2
Delamination on a stub-T sleeper

Condition State 3
Bituminous patch on a low slump concrete overlay

#510: Wearing Surface – Concrete (SF)
#810: Low Slump Dense Concrete (LSDC) Overlay (SF)
#811: Latex Modified Concrete (LMC) Overlay (SF)
#832: Fiber Concrete Overlay (SF)
#833: Concrete Overlay (A40 or A45) Overlay (SF)

Condition Rating Examples (Concrete Overlays)

Condition State 3
Map cracking (1/16″ or 0.06″ wide) with failed sealant on a low slump overlay

Condition State 3
Crack (1/16″ or 0.06″ wide) in a low slump overlay

Condition State 3
Transverse crack ($^{1}/_{16}$″ or 0.06″ wide) on a bare concrete deck

Condition State 3
Map cracked area with rust staining on a bare concrete deck

Condition State 4
Failed bituminous patch on a low slump overlay

Condition State 4
Failed patch on low slump concrete overlay

3.5.9 Asphalt Concrete Wearing Surfaces (Elements #510, #813, #814, and #831)

#510: Wearing Surface – Bituminous (SF)
#813: Asphalt Concrete with Membrane Overlay (SF)
#814: Asphalt Concrete without Membrane Overlay (SF)
#831: Rubberized Asphalt Chip Seal Overlay (SF)

Bituminous wearing surfaces are mainly found on older (pre-1970's) concrete bridge decks, laminated timber bridge decks, or timber slab span bridges.

Item or Defect	Structural Element Condition States			
	1 Good	2 Fair	3 Poor	4 Severe
Potholes, Patching, or Repairs. (3210)	None.	Less than ½" deep. Patches that remain sound.	½" to 1½" deep (underlying deck is not exposed). Deteriorated patches or repairs.	Deeper than 1½" (or underlying deck is exposed). Repair patches that have failed.
Wear or Rutting (Use 3230)	Minor wearing, no rutting.	Moderate wearing or minor rutting.	Significant wearing or rutting.	Severe wearing or rutting.
Cracking (3220)	Insignificant cracks	Moderate (up to ½") unsealed cracks **or** sealed cracks.	Significant (½" to 1½") unsealed cracks.	Severe (greater than 1½") unsealed cracks.

Condition Rating Examples (Bituminous Wearing Surfaces)

Condition State 2
Sealed crack on a bituminous overlay.

Condition State 2
Sound patches on a bituminous overlay.

Condition State 3
Significant cracking on a bituminous overlay.

Condition State 4
Pothole (2" deep) in bituminous overlay.

3.5.10 Epoxy/Polymer Chip Seal Deck Wearing Surfaces (Elements #510 or #812)

#510: Deck Wearing Surface (SF)	#812: Epoxy/Polymer Chip Seal Overlay (SF)			
Epoxy/polymer chip seal overlays are comprised of a thin single or two-layer epoxy or polymer covered with small coarse aggregates. They are used on new and existing concrete decks, bare decks, as well as decks that already had a concrete overlay.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Delamination, Adhesion Failure, Patching, or Repairs (3210)	None.	Delamination of epoxy layer. Permanent patches that remain sound.	Bubbling of the epoxy layer. Temporary patches **or** deteriorated repairs.	Epoxy layer loose or missing. Repair patches that have failed.
Cracking (3220)	None	Minor to moderate cracks. Reflecting through the ECS/PCS layer.	Significant cracks. Cracked completely through the ECS overlay.	Failed or missing.
Scale, Wear, Abrasion, Effectiveness (Use 3230)	None	Minor to moderate aggregate loss or polishing of surface (no significant friction loss).	Significant loss of aggregate or polishing of surface (noticeable loss of friction).	Severe wear – loss of friction could pose a hazard in adverse weather conditions.

Condition Rating Examples (Epoxy/Polymer Chip Seal Overlay)

Condition State 2
Repair patch on a chip seal overlay.

Condition State 2
Minor to moderate cracking on a chip seal overlay.

Condition State 3
Significant cracking on a chip seal overlay.

Condition State 4
Chip seal overlay missing & peeling.

3.5.11 Timber Deck Wearing Surfaces (Elements #510 or #830)

#510: Deck Wearing Surface – Timber Planks (SF) #830: Timber Running Plank (SF)				
The wearing surface element is not used for bare timber decks. This element is intended only for timber decks that have an additional layer of timber wearing planks (typically orientated parallel to traffic). Wearing planks may be present over the entire deck, or only along the wheel tracks.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Connections	Timber wearing planks are properly aligned and solidly attached.	Timber planks are slightly loose or misaligned.	Timber planks are significantly loose or misaligned.	Timber planks are loose or missing.
Timber Deterioration	Minor weathering or splitting.	Moderate weathering or splitting. Minor decay.	Significant splitting, decay, or section loss (no crushing or sagging).	Severe splitting, decay, or loss of section (crushing or sagging).

Condition Rating Examples (Timber Wearing Planks)

Condition State 1
Minor weathering on timber wearing planks.

Condition State 2
Moderate weathering on a timber wearing plank.

Condition State 3
Significant decay on timber wearing planks.

Condition State 4
Section of timber wearing plank missing.

3.5.12 Gravel Deck Wearing Surfaces (Elements #510 or #809)

#510: Deck Wearing Surface – Gravel (SF) #809: Gravel Wearing Surface (SF)				
A gravel (or dirt) wearing surface may be present on concrete or timber bridge decks. As gravel roads are periodically graded, the gravel depth on the bridge deck may vary. The inspector should attempt to determine the depth of gravel present on a bridge deck, as it may be a significant dead load on the bridge.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
General Deterioration	Gravel is evenly graded and flat.	Minor to moderate rutting, wash boarding, or ponding.	Significant rutting, wash boarding, or ponding.	Severe rutting, wash boarding, or ponding.
Gravel Depth	Less than 4”.		4” to 6”.	More than 6”.

Condition Rating Examples (Gravel Wearing Surface)

Condition State 1
Gravel evenly graded and smooth.

Condition State 2
Moderate ponding on a gravel wearing surface.

Condition State 3
Significant rutting on a gravel wearing surface.

Condition State 4
Excessive gravel on a deck (more than 6” depth).

3.5.13 Concrete Reinforcing Steel Protective Systems (Elem #520, #820, #821, and #822)

#520: Concrete Reinforcing Steel Protective System (SF) #820: Epoxy Coated Resteel (SF) #821: Stainless Resteel (SF) #822: Zinc and Epoxy Coated Resteel (SF)				
This element is primarily intended for concrete reinforcing steel that is not plain black steel. It could be used anywhere a reinforcing steel protective coating is found (decks, slabs, approaches, barriers, etc.). These coatings will generally be effective slowing down the rate of corrosion of the reinforcing steel. These coatings are difficult to see or inspect. The inspector should look for obvious signs of leaching through cracks on the underside of the element in question if access is available.				
Defect or Item	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Effectiveness (3600)	Fully effective.	Substantially effective.	Limited effectiveness.	The system has failed or is no longer effective.
• Quantities are figured based on the square foot area of the parent element. • Barriers – (front side height + width + backside height) x element length. • Decks/Slabs – Deck/Slab area x number of resteel mats.				

4.2.1.1 Concrete Protective Coatings (Elements #521, #825, #826, and #827)

#521: Concrete Protective Coating (SF) #825: Silanes/Siloxanes (SF) #826: Methacrylates (SF) #827: Silicates (SF)				
This element is primarily intended for concrete bridge decks that have been flood sealed with High Molecular Weight Methacrylate (HMWM) sealants. It could also be used for decks coated with Silane or Siloxane water-proofers, or similar products. These coatings will generally be effective at sealing cracks for about 5-6 years, or potentially longer. These coatings are difficult to see or inspect. The inspector should look for obvious unsealed cracks on the wearing surface or obvious leakage through cracks on the underside of the deck. **Note: This element does not apply to epoxy or polymer chip seal overlays – they should be rated using Element #812.**				
Defect or Item	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Wear (3510)	None.	Underlying concrete not exposed; Coating showing wear from UV exposure; friction coarse missing.	Underlying concrete is not exposed; thickness of coating is reduced.	Underlying concrete exposed. Protective coating no longer effective.
Effectiveness (3540)	Fully effective.	Substantially effective.	Limited effectiveness.	The system has failed or is no longer effective.
Unsealed Cracks (3540)	Unsealed insignificant cracks (less than 0.012” wide).	Unsealed moderate cracks (from 0.012” wide up to 0.05” wide).	Unsealed wide cracks (greater than 0.05” wide up to 0.125” wide).	Unsealed severe cracks (greater than 0.125”).
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1’ wide for ease of calculations and consistency.				

3.6 JOINT ELEMENTS

3.6.1 Joint Elements

SDDOT has seven structural elements to rate the condition of bridge or approach joints:

- #300 – Strip Seal Expansion Joint (LF)
- #301 – Pourable Joint Seal (LF)
- #302 – Compression Joint Seal (LF)
- #303 – Modular Assembly Joint with Seal (LF)
- #304 – Open Expansion Joint (LF)
- #305 – Assembly Joint without Seal (LF)
- #306 – Other Joint (LF)

Joint Element Quantities

For most joints, the plan quantity (LF) will be entered as the element quantity. This will typically include the roadway portion of the joint but should also include portions of the joint that extend through railings or under sidewalks and medians.

On bridge deck joints, steel cover plates are often present at the curbs, medians, sidewalks, and railings. These cover plates are a component of the deck joint and should be rated as part of the deck joint element. If a sealed joint (such as a strip seal or modular joint) extends below a sidewalk or median, that section should be rated under the strip seal or modular joint element. If the seal does not extend below the sidewalk or median, that portion of the joint should be rated under a separate deck joint element (typically Element #305 – Assembly Joint).

Inspection of Joints

Joints should be inspected for leakage, as well as for proper function. Joint leakage is a significant concern due to de-icing salt applied to roadways and sidewalks. Joint leakage that results in damage to the bridge superstructure or substructure below the joint should result in a lowered condition rating, even if the joint is not designed or intended to be sealed.

Joints should be examined for skew, offset, or any evidence that the joint is restricted or is beyond the limits of expansion or contraction. Expansion joints that are closed tightly, offset vertically or horizontally, or have large gaps may indicate severe structural problems (such as substructure movement).

Joint Measurements

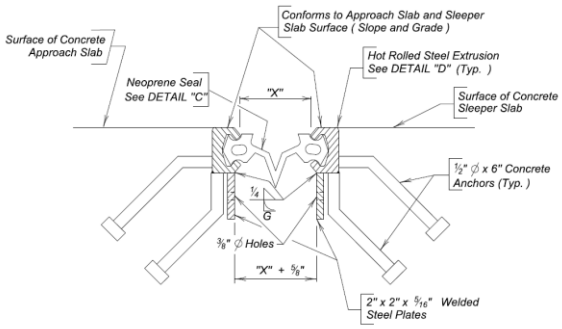
To confirm that the expansion joints are properly functioning, joint measurements are recommended to be collected at every inspection and the substrate temperature recorded. Joint measurements should be taken at the same location, in a consistent manner, and ideally under a wide range of temperatures.

A common place to take joint gap measurements is at center line of the roadway and lane stripes. The gap between the inside vertical faces of the joint is typically measured. Measurements can also be taken at railing gaps or at sidewalk or curb cover plates. Recent scrape marks along the edges of cover plates are a good indication that the joint is expanding and contracting.

3.6.2 Strip Seal Expansion Joint (Element #300)

#300: Strip Seal Expansion Joint (LF)

This element applies to joints that utilize a single line "V" shaped neoprene gland, typically held in place by a steel extrusion. Strip seal joints are one of the more common types of bridge and approach expansion joints used in the state.



Item or Defect	Structural Element Condition States			
	1 Good	2 Fair	3 Poor	4 Severe
General Joint Condition	Little or no deterioration.	Minor to moderate deterioration (no repairs needed).	Strip seal gland repair or replacement is recommended.	Joint reconstruction, seal replacement, or concrete repair work is required.
Joint Function and Alignment	Horizontal joint gap is within design limits.	Joint gap is at or near design limits.	Joint is closed to less than ½" or has opened beyond design limits.	Joint is closed or has failed.
	No vertical offset.	Vertical offset of ¼" or less.	Vertical offset of ½" or less.	Vertical offset greater than ½".
Leakage (2310)	None	Minimal leakage (slight dripping).	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Damage (2330)	Securely anchored and properly positioned.	Seal abrasion without punctures.	Strip seal gland is partially pulled out of the extrusion/opening, punctured, or ripped.	The seal is torn, punctured, pulled out from the extrusion/opening, or is missing.
Debris Impaction (2350)	No debris to a shallow cover of loose debris	Partially filled with hard-packed material. Still allows free movement.	Completely filled and **impacts** joint movement.	Completely filled and **prevents** joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1" or less deep or 6" or less in diameter. No exposed rebar. Patched area is sound.	Spall greater than 1" deep or greater than 6" in diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patch, or loose anchor joint that prevents the joint from functioning as intended.
Metal Deterioration or Extrusion Damage (2370)	Minor surface corrosion or superficial scrapes.	Corrosion. No cracks or impact damage. Nicks/gouges ¼" deep or less.	Section loss. Cracking or impact damage, but still functioning. Nicks/gouges greater than ¼" deep.	Cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.

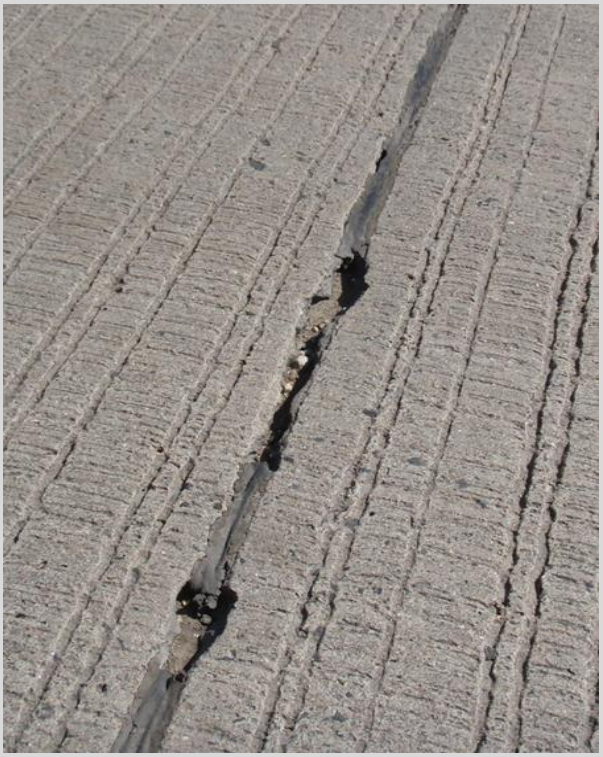
#300: Strip Seal Expansion Joint (LF) Condition Rating Examples (Strip Seal Deck Joints)	
 **Condition State 2** **Strip seal gland partially pulled out**	 **Condition State 4** **Hole in strip seal gland**
 **Condition State 3** **Strip seal deck joint closed to less than a ½" gap**	 **Condition State 4** **Joint open beyond design limits (5" gap) – the gland has pulled out of the steel extrusion**

3.6.3 Poured Joint Seal (Element #301)

#301: Poured Joint Seal (LF)				
This element applies to joints filled with a poured or extruded sealant – this typically refers to transverse saw and seal joints (above piers or along end blocks) but can include any poured joint on the bridge deck or on a concrete bridge approach panel.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
General Joint Condition	Little or no deterioration.	Minor to moderate deterioration (no repairs needed).	Seal repair or replacement is recommended.	Joint reconstruction, seal replacement, or concrete repair work is required.
Joint Function and Alignment	Horizontal joint gap is within design limits.	Joint gap is at or near design limits.	Joint is closed to less than ½" or has opened beyond design limits.	Joint is closed or has failed.
	No vertical offset.	Vertical offset of ¼" or less.	Vertical offset of ½" or less.	Vertical offset greater than ½".
Leakage (2310)	None.	Minimal leakage (slight dripping).	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion (2320)	Joint is properly adhered.	Adhered for more than 50% of joint height.	Adhered 50% or less of joint height, but still some adhesion.	Complete loss of adhesion.
Seal Damage (2330)	Securely anchored and properly positioned.	Seal abrasion without punctures.	Seal gland is partially pulled out of the extrusion/opening, punctured, or ripped.	The seal is torn, punctured, pulled out from the extrusion/opening, or is missing.
Debris Impaction (2350)	No debris to a shallow cover of loose debris	Partially filled with hard-packed material. Still allows free movement.	Completely filled with hard-packed material and **impacts** joint movement.	Completely filled and **prevents** joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1" or less deep or 6" or less in diameter. No exposed rebar. Patched area is sound.	Spall greater than 1" deep or greater than 6" in diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patch, or loose anchor joint that prevents the joint from functioning as intended.

#301: Poured Joint Seal (LF)

Condition Rating Examples (Poured Deck Joints)



Condition State 3
Section of poured seal missing

Condition State 4
Cracking and delamination adjacent to a transverse poured deck joint

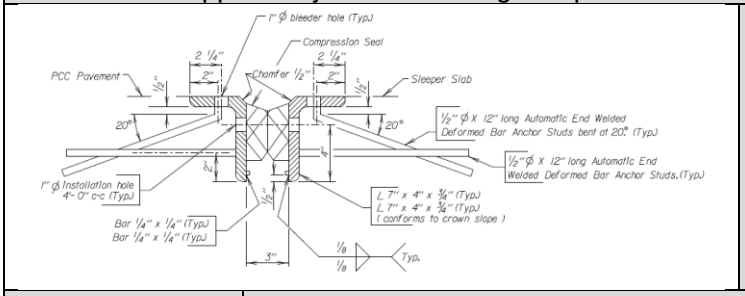
Condition State 4
Extensive deck deterioration (bituminous patching) along transverse poured deck joints

Condition State 4
Severe spalling along a longitudinal poured joint

3.6.4 Compression Joint Seal (Element #302)

#302: Compression Joint Seal (LF)

This element applies to joints consisting of a pre-formed elastic or foam membrane compression seal.



Compression seals may have a solid or hollow cross-section. The joint may or may not include steel protection angles along the deck edges.

A cross-section plan diagram of typical compression seal deck joint (with steel protection angles) is shown at left.

Item or Defect	Structural Element Condition States			
	1	2	3	4
	Good	Fair	Poor	Severe
General Joint Condition	Little or no deterioration	Minor to moderate deterioration (no repairs needed).	Compression seal gland repair or replacement is recommended.	Joint reconstruction, seal replacement, or concrete repair work is required.
Joint Function and Alignment	Horizontal joint gap is within design limits.	Joint gap is at or near design limits.	Joint is closed to less than ½" or has opened beyond design limits.	Joint is closed or has failed.
	No vertical offset.	Vertical offset of ¼" or less.	Vertical offset of ½" or less.	Vertical offset greater than ½".
Leakage (2310)	None	Minimal leakage (slight dripping).	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion (2320)	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered for 50% or less of the joint height, but still some adhesion.	Complete loss of adhesion.
Seal Damage (2330)	Securely anchored and properly positioned.	Seal abrasion without punctures.	The gland is partially pulled out of the extrusion/opening, punctured, or ripped.	The seal is torn, punctured, pulled out from the extrusion/opening, or is missing.
Debris Impaction (2350)	No debris to a shallow cover of loose debris	Partially filled with hard-packed material. Still allows free movement.	Completely filled with hard-packed material and **impacts** joint movement.	Completely filled and **prevents** joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1" or less deep or 6" or less in diameter. No exposed rebar. Patched area is sound.	Spall greater than 1" deep or greater than 6" in diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patch, or loose anchor joint that prevents the joint from functioning as intended.
Metal Deterioration or Extrusion Damage (2370)	Minor surface corrosion or superficial scrapes.	Corrosion. No cracks or impact damage. Nicks/gouges less than ¼" deep.	Section loss. Cracking or impact damage, but still functioning. Nicks/gouges greater than ¼" deep.	Cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.

#302: Compression Joint Seal (LF)

Condition Rating Examples (Compression Joint Seal)

Condition State 2
Plow damage on steel protection angle along compression joint

Condition State 4
Compression seal gland has dropped out of joint

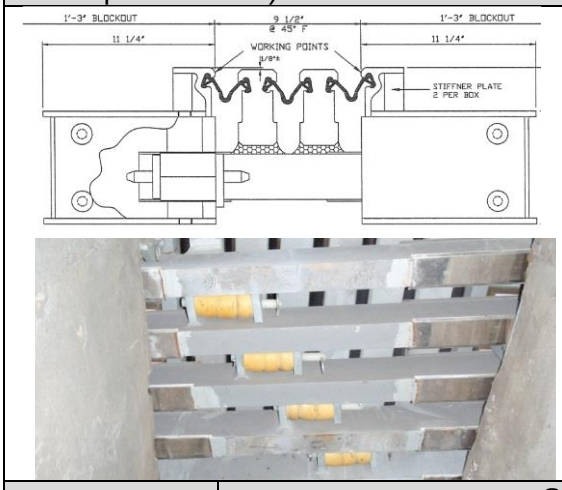
Condition State 4
Steel protection angle on a compression seal joint fractured and separated

Condition State 4
Severe spalling (temporary patch) along a compression seal joint

3.6.5 Assembly Joint with Seal (Element #303)

#303: Assembly Joint with Seal (LF)

This element only applies to modular joints comprised of two or more adjacent waterproof seals ("V" strip or compression seal).



A cross-section diagram of a 3-gland modular deck joint is shown at left.

The seals are anchored by steel extrusions cast into the deck and are typically supported from below by small beams (with an independent expansion bearing system). Modular joints typically incorporate equalizer springs and guide systems to keep the seals equally spaced and properly aligned. The underside support beams and equalizer system on a 7-gland modular joint is shown at left.

Item or Defect	Structural Element Condition States			
	1	2	3	4
	Good	Fair	Poor	Severe
Joint Function and Alignment	Horizontal joint gap is within design limits.	Joint gap is at or near design limits.	Joint is closed to less than ½" or has opened beyond design limits.	Joint is closed or has failed.
	No vertical offset.	Vertical offset of ¼" or less.	Vertical offset of ½" or less.	Vertical offset greater than ½".
Leakage (2310)	None	Minimal leakage (slight dripping).	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Damage (2330)	Securely anchored and properly positioned.	Seal abrasion without punctures.	Strip seal gland is partially pulled out of the extrusion/opening, punctured, or ripped.	The seal is torn, punctured, pulled out from the extrusion/opening, or is missing.
Support Beams and Equalizer System	Little or no deterioration	Minor to moderate deterioration (no repairs needed).	Components loose, missing, or malfunctioning. Joint support loose or misaligned.	Joint support is dislodged, jammed, detached, or missing.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1" or less deep or 6" or less in diameter. No exposed rebar. Patched area is sound.	Spall greater than 1" deep or greater than 6" in diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patch, or loose anchor joint that prevents the joint from functioning as intended.
Metal Deterioration or Extrusion Damage (2370)	Minor surface corrosion or superficial scrapes.	Corrosion. No cracks or impact damage. Nicks/gouges less than ¼" deep.	Section loss. Cracking or impact damage, but still functioning. Nicks/gouges greater than ¼" deep.	Cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.

#303: Assembly Joint with Seal (LF)

Condition Rating Examples (Assembly Joints with Seals)

Condition State 1
Minor surface corrosion on steel extrusions (debris is not affecting the joint function)

Condition State 2
Minor leakage (with surface corrosion) on underside of a modular joint

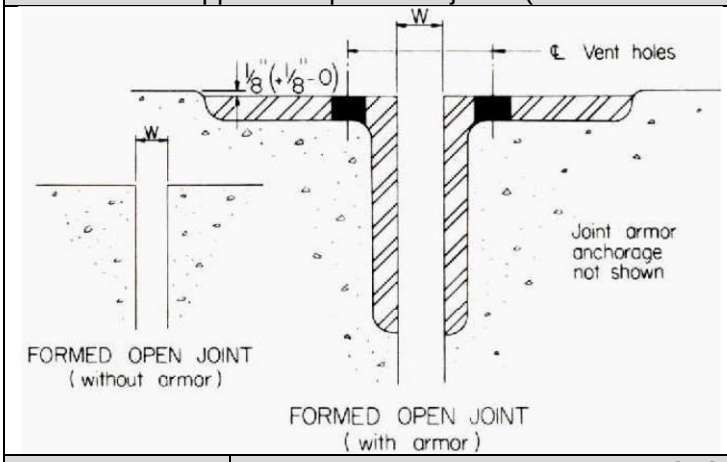
Condition State 3/4
Modular joint gaps are uneven (equalizer system is not functioning properly) - one gland is pulled out.

Condition State 4
Support missing from underside of modular joint - gland has fallen out and is hanging down

3.6.6 Open Expansion Joint (Element #304)

#304: Open Expansion Joint (LF)

This element applies to open deck joints (with or without steel protection angles).



Due to the heavy use of chlorides on roadways during the winter months, open joints are rarely used on bridge decks in South Dakota.

Leakage through an open deck joint should be considered in the condition rating if it is contributing to deterioration of superstructure or substructure elements located below the joint.

Item or Defect	Structural Element Condition States			
	1 Good	2 Fair	3 Poor	4 Severe
Joint Function and Alignment	Horizontal joint gap is within design limits.	Joint gap is at or near design limits.	Joint is closed to less than ½" or has opened beyond design limits.	Joint is closed or has failed.
	No vertical offset.	Vertical offset of ¼" or less.	Vertical offset of ½" or less.	Vertical offset greater than ½".
Leakage (2310)	None	Minimal leakage (slight dripping).	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1" or less deep or 6" or less in diameter. No exposed rebar. Patched area is sound.	Spall greater than 1" deep or greater than 6" in diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patch, or loose anchor joint that prevents the joint from functioning as intended.
Metal Deterioration or Extrusion Damage (2370)	Minor surface corrosion or superficial scrapes.	Corrosion. No cracks or impact damage. Nicks/gouges less than ¼" deep.	Section loss. Cracking or impact damage, but still functioning. Nicks/gouges greater than ¼" deep.	Cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.

Note: Joint leakage through the joint should be considered in the condition rating, particularly if it is contributing to deterioration of superstructure or substructure elements located below the joint.

#304: Open Expansion Joint (LF)

Condition Rating Examples (Open Expansion Joints)

Condition State 2
Minor spalling along an open deck joint

Condition State 3
Leakage through and open deck joint resulting in severe corrosion of superstructure below

Condition State 3
Moderate spalling along an open deck joint (does not impact function or present a safety hazard)

Condition State 4
Open joint contacting at curb (no further expansion is permitted) – deck is offset laterally

3.6.7 Assembly Joint without Seal (Element #305)

#305: Assembly Joint without Seal (LF)				
This element applies to finger plate joints, sliding plate joints, or any other joint that cannot be adequately defined by the other joint elements. **Note:** This element includes joints with or without seals or drainage systems. Joint leakage should be considered in the condition rating, particularly if it is contributing to deterioration of superstructure or substructure elements located below the joint. This includes a drainage trough or gland, if applicable.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
General Joint Condition	Joint is functioning as intended (no restriction).	Slight restriction of joint movement.	Moderate to significant restriction of joint movement, but not completely restricted.	Joint is completely restricted (not functioning).
Joint Function and Alignment	Horizontal joint gap is within design limits.	Joint gap is at or near design limits.	Joint is closed to less than ½" or has opened beyond design limits.	Joint is closed or has failed.
	No vertical offset.	Vertical offset of ¼" or less.	Vertical offset of ½" or less.	Vertical offset greater than ½".
Leakage – with Seals (2310)	None	Minimal leakage (slight dripping).	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Leakage – without Seals (2310)	Leakage is effectively directed away from structure below.	Leakage through joint is causing minor damage to the structure below.	Leakage through joint is causing significant damage to the structure below.	Leakage through joint is causing severe or extensive damage to the structure below
Seal Damage (2330)	Securely anchored and properly positioned.	Seal abrasion without punctures.	The seal is partially pulled out of the extrusion/opening, punctured, or ripped.	The seal is torn, punctured, pulled out from the extrusion/opening, or is missing.
Adjacent Deck or Header (2360)	Sound. No spalls, delaminations, or patching.	Edge delamination or spall 1" or less deep or 6" or less in diameter. No exposed rebar. Patched area is sound.	Spall greater than 1" deep or greater than 6" in diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patch, or loose anchor joint that prevents the joint from functioning as intended.
Steel Plate Anchorage	Steel plates are properly anchored (no noise under traffic).	Plates may be slightly loose (minor noise under traffic).	Plate is loose (noise under traffic) – anchor bolts are loose or missing.	The plate is loose and may fail under traffic (causing damage) or is missing.
Metal Deterioration or Extrusion Damage (2370)	Minor surface corrosion or superficial scrapes.	Corrosion. No cracks or impact damage. Nicks/gouges less than ¼" deep.	Section loss. Cracking or impact damage, but still functioning. Nicks/gouges greater than ¼" deep.	Cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.

#305: Assembly Joint without Seal (LF)

Condition Rating Examples (Assembly Joints without Seal)

Condition State 2
Anchor bolt covers missing from a "Wabo®Flex" deck expansion joint

Condition State 3
Spalling and temporary patching along a sliding plate deck joint (does not impact joint function)

Condition State 3
Finger joint laterally misaligned (fingers contacting)

Condition State 4
Finger joint is opened beyond design limits (gap between the two finger plates)

3.7 BRIDGE RAILING ELEMENTS

Bridge railing elements apply to railing mounted on or attached to bridge decks, approaches, or wingwalls. This includes vehicular barriers, ornamental railing, pedestrian fencing, and handrails. Railing elements can also be used for railings directly connected to culvert structures.

SDDOT uses the following bridge railing elements:

- **#330: Metal Bridge Railing (LF)**
- **#331: Reinforced Concrete Bridge Railing (LF)**
- **#332: Timber Bridge Railing (LF)**
- **#333: Other Material Bridge Railing (LF)**
- **#334: Masonry Bridge Railing (LF)**

Railing element quantities are expressed in linear feet (LF). The quantity is measured along the length of the railing (for each railing line). Most bridges will have two railing lines (one on each side), but there may be additional rail lines if there is a median barrier or a protected bicycle or pedestrian lane. Solid median barriers are counted as one line – split median barriers are counted as two lines. The railing quantity may include approach railing (generally up to the first approach joint beyond the end of the bridge) but could include railing extending beyond that point if those railing sections are included in the plan quantity for the bridge.

<table>
<tr><th colspan="3">Railing Element Selection Examples for Combination Railings</th></tr>
<tr><td colspan="3">Railings comprised of more than one material should be broken up into separate elements to best represent the materials present. Some examples for common railing types are shown below.</td></tr>
<tr><td>For concrete parapets/curbs with metal railing mounted on top, the railing must be spilt into two elements.
The lower parapet or curb is rated using Element #331 (Concrete Railing) and the upper rail is rated using Element #330 (Metal Railing) – the element quantities may or may not be the same depending on the bridge plans.</td><td>  </td><td>  </td></tr>
<tr><td>If the railing can be logically divided into separate material segments, those segments should be rated under separate elements.
The metal segments are rated using Element #330 (Metal Railing) and the concrete posts are rated using Element #331 (Concrete Railing). Quantities should reflect the total length of the segments.</td><td>  </td><td>  </td></tr>
<tr><td>For masonry railings with a concrete top cap, the railing is split into two elements.
The lower parapet/curb is rated using Element #334 (Masonry Railing) and the top cap is rated using Element #331 (Concrete Railing).</td><td colspan="2">  </td></tr>
<tr><td>For steel plate beam railing with timber posts & curbs, the railing should be split into two elements.
The steel w-beam or thrie-beam is rated using Element #330 (Metal Railing). The timber posts and curb are rated using Element #332 (Timber Railing).</td><td colspan="2">  </td></tr>
<tr><td colspan="3">Metal railings (Element #330) are typically painted, galvanized, or both (galvanized then painted). If a protective coating is present, Element #515, 815, 816, 817, or 818 (Steel Protective Coatings) must also be rated as a protection system/sub-element. The SF quantity may be estimated by multiplying the railing length by the front-side railing height, plus the overall width/depth, plus the backside height. This SF quantity may initially be entered as a rough estimate, but a more accurate quantity should eventually be calculated.</td></tr>
</table>

3.7.1 Metal Bridge Railing (Element #330)

#330: Metal Bridge Railing (LF)				
This element applies to railings comprised of steel, stainless steel, aluminum, or any other metal. This includes tubes, pipes, cables, beams, or other rolled, cast, or built-up shapes. This includes vehicular railings, pedestrian railings, and chain link fence. This element includes railings constructed entirely of metal, as well as the metal portions of combination railings. The other components of a combination railing should be rated separately using the appropriate railing element (concrete, timber, or masonry). Metal railings typically have a protective coating – they may be painted, galvanized, or both (galvanized then painted). Chain link fence is typically galvanized, or vinyl coated. Aluminum or stainless-steel railings typically have no protective coating.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** review of existing defects has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** review has determined that defects impact strength or serviceability.
Repairs	No repairs are present.	Existing repairs are in sound condition.	Repairs are recommended **or** existing repairs are unsound.	Immediate repairs are required.
Corrosion (1000)	None	Surface corrosion (freckled rust).	Section loss or pack rust (greater than 1/8”) is present.	Severe section loss (holes rusted through).
Cracking (1010)	None	Crack has self-arrested or has been arrested or repaired.	Crack that has not been arrested.	Crack through the member that warrants immediate repair.
Connection (1020)	Connections are in place, properly aligned, and functioning as intended.	Loose fasteners, minor to 1/8” pack rust,	Broken or missing bolts, rivets, welds, or other fasteners.	Less than 50% of connections at the location remaining.
Distortion or Alignment (1900)	None. Proper alignment.	Mitigated distortion or mitigation not required. Slightly misaligned.	Distortion that requires mitigation that has not been addressed. Significantly misaligned.	Severely bent or bowed. Severely misaligned.
Impact Damage (7000)	Superficial damage.	Railing slightly gouged, torn or bent.	Railing significantly gouged, torn or bent.	Railing severely bent, torn, or missing.

#330: Metal Bridge Railing (LF)

Condition Rating Examples (Metal Bridge Railing)

Condition State 2
Surface corrosion on steel rail beams

Condition State 3
Steel angle railing bent significantly

Condition State 4
Horizontal steel rail pipe rusted through at connection to a concrete post

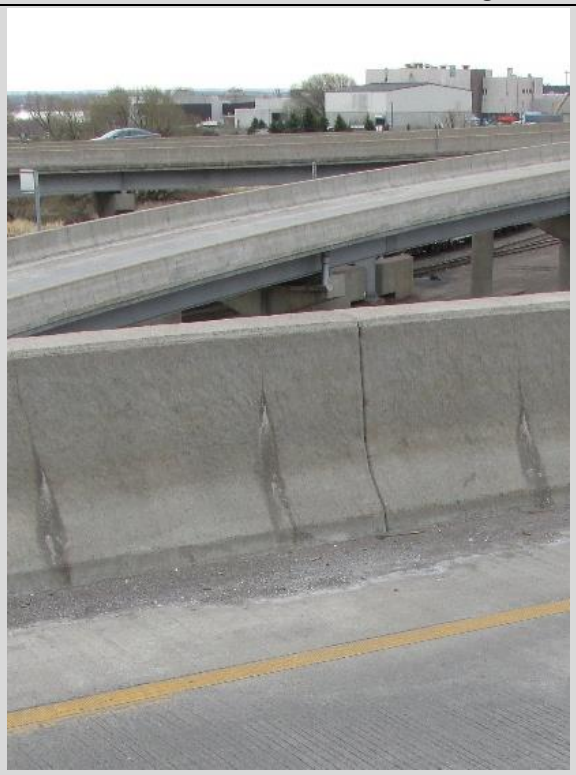
Condition State 4
Aluminum rail post severely damaged

3.7.2 Reinforced Concrete Bridge Railing (Element #331)

#331: Reinforced Concrete Bridge Railing (LF)				
This element applies to all types and shapes of reinforced concrete bridge railings or barriers. This includes railings constructed entirely of reinforced concrete, as well as the reinforced concrete curb (or "parapet") portions of combination railings. The other components of a combination railing should be rated separately using the appropriate railing element (metal, timber, or masonry).				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** review of existing defects has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** review has determined that defects impact strength or serviceability.
Repairs	No repairs are present.	Existing repairs are in sound condition.	Repairs are recommended **or** existing repairs are unsound.	Immediate repairs are required.
Delamination, Spall, Patched Area (1080)	None	Delamination (not yet loose). Spall 1" or less deep **and** 6" or less in diameter. Repaired area is sound.	Loose delamination. Spall more than 1" deep **or** more than 6" diameter. Repaired area is unsound or distressed.	Loose delamination (safety hazard). Spalling greater than 3" deep. Full-depth failures present or imminent.
Exposed Reinforcement (1090)	None	Exposed without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Efflorescence, Rust Staining or Leaching (1120)	None	Light efflorescence or leaching (little or no build-up.	Heavy efflorescence or leaching (significant build-up or stalactites). Rust stains indicating rebar corrosion.	Severe efflorescence or leaching (concrete unsound).
Cracking and Pattern/Map Cracking (1130)	Insignificant cracks (less than 0.012") or moderate width cracks that have been sealed.	Unsealed moderate (0.012" to 0.05") width cracks. Unsealed moderate density pattern/map (spacing of greater than 1' to 3' on center) with moderate width cracking.	Wide (greater than 0.05" to 0.125") cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1' or less on center).	Severe (greater than 0.125") cracks or full depth fractures. Failure may be plausible.
Scale, Abrasion, or Wear (1190)	Superficial.	Coarse aggregate is exposed (½" deep or less) but remains secure in the concrete matrix.	Coarse aggregate is loose (greater than ½" to 3") or popped out of the concrete matrix.	Severe voiding (greater than 3") or concrete is unsound.
Damage (7000)	Superficial scrapes.	Minor to moderate impact damage.	Significant impact damage.	Severe impact damage.
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1' wide for ease of calculations and consistency. • As a general rule, pattern or map cracked areas or areas with concentrated cracking should be documented and are rated as a LF area – use engineering judgement.				

#331: Reinforced Concrete Bridge Railing (LF)

Condition Rating Examples (Concrete Bridge Railing)



Condition State 2
Vertical cracks with light leaching in a concrete jersey barrier

Condition State 2
Repair patch on a concrete parapet of a combination railing

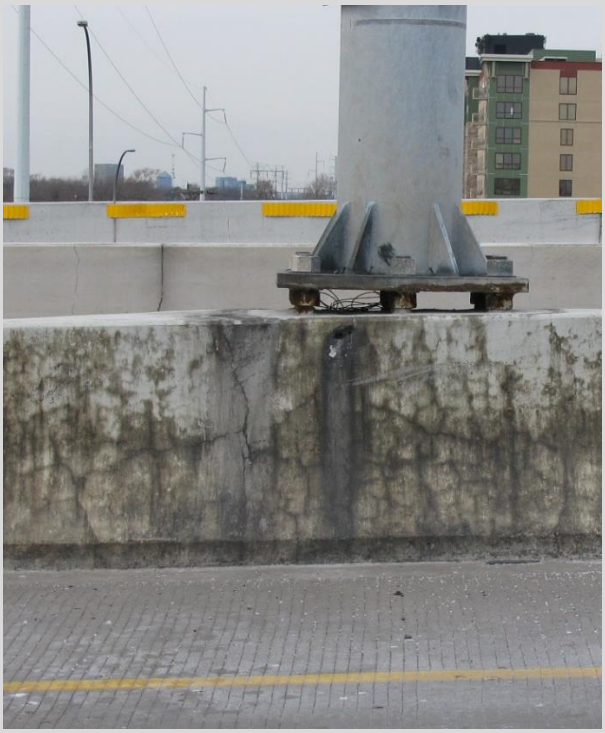
Condition State 2
Scale on a concrete jersey barrier

Condition State 2
Scale and pop-outs on a concrete parapet railing

#331: Reinforced Concrete Bridge Railing (LF)

Condition Rating Examples (Concrete Bridge Railing)

Condition State 2/3
Map cracking on a concrete post & beam railing



Condition State 3
Map cracking and staining on concrete jersey barrier below an overhead sign support

Condition State 3
Spalling/scaling along the top of a concrete jersey barrier

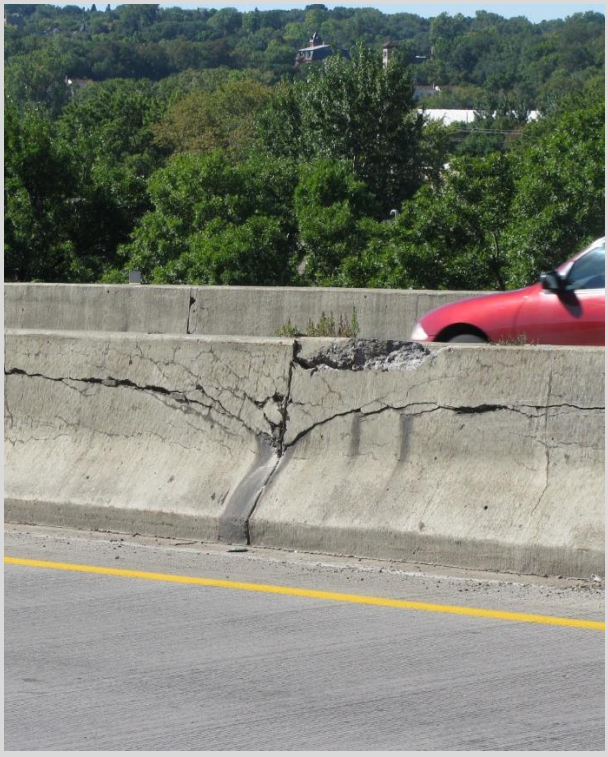
Condition State 3
Spalling and exposed rebar on the concrete parapet of a combination railing

#331: Reinforced Concrete Bridge Railing (LF)

Condition Rating Examples (Concrete Bridge Railing)

Condition State 3
Scale/spall on a concrete end post

Condition State 4
Severe spall and fracture on a concrete post



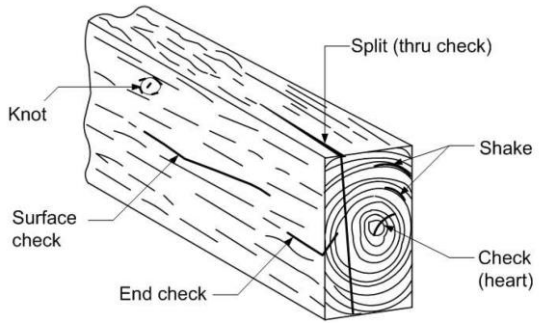
Condition State 4
Severe fracture and cracking in a concrete median double-sided jersey barrier

Condition State 4
Severe spalling on the concrete rail base of a combination railing

3.7.3 Timber Bridge Railing (Element #332)

#332: Timber Bridge Railing (LF)				
This element applies all types and shapes of timber railing. This includes railings constructed primarily of timber (the connections are typically steel), as well as the timber portions of combination railings. The other components of a combination railing should be rated separately using the appropriate railing element (metal, concrete, or masonry).				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** review of existing defects has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** review has determined that the defects impact strength or serviceability.
Repairs	No repairs are present.	Existing repairs are in sound condition.	Repairs are recommended **or** existing repairs are unsound.	Immediate repairs are required.
Misalignment	None	Slightly misaligned.	Significantly misaligned.	Severely misaligned.
Connection (1020)	Connection in-place and functioning.	Loose fasteners, but connection is functioning.	Missing fasteners; broken welds; or pack rust with distortion.	Connection has failed (or failure is eminent).
Section Loss (1140 or 1180)	Minor deterioration (no section loss).	Less than 10% section loss. No crushing or sagging.	More than 10% section loss. Some crushing or sagging.	More than 10% section loss. Severe crushing or sagging.
Shakes or Checks (1150)	Less than 5% of the member thickness	5% to 50% of the member thickness and not in a tension zone.	More than 50% of the thickness (or more than 5% of the member thickness in a tension zone).	Split through entire member (or more than 25% of the member thickness in a tension zone).
Crack (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that has not been arrested and does not require structural review.	Severe cracks or full depth fractures. Failure may be plausible.
Split or Delamination (1170)	None.	Minor	Significant.	Severe.
Impact Damage (7000)	Superficial damage.	Minor to moderate impact damage.	Significant impact damage.	Members severely damaged, detached, or missing.

- **Shake:** A separation along the grain (between the growth rings). Usually forms within a standing tree or during felling.
- **Check:** A separation perpendicular to the grain (across the growth rings). Usually results from stress due to drying shrinkage.
- **Split (or Thru Check):** A check extending further through the timber member due to tearing apart of wood cells.



#332: Timber Bridge Railing (LF)

Condition Rating Examples (Timber Bridge Railing)

Condition State 2
Checks in a timber rail post

Condition State 3
Significant decay on a timber rail beam

Condition State 4
Timber rail post missing (adjacent post is severely damaged)

Condition State 4
Timber rail beam detached from posts

3.7.4 Other Material Bridge Railing (Element #333)

#333: Other Material Bridge Railing (LF)				
This element applies to bridge railings where the primary material is something other than metal, concrete, timber, or masonry. This includes railings comprised of glass, acrylic, or other transparent materials. Note: The other components of a combination railing should be rated separately using the appropriate railing element (metal, concrete, masonry, or timber).				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review of has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** structural review has determined that the defects impact strength or serviceability.
Repairs	No repairs are present.	Existing repairs are in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
General Deterioration	Superficial deterioration.	Minor to moderate deterioration.	Significant deterioration.	Severe deterioration.
Transparent Materials (Glass, Acrylic, Etc.)	May be dirty, but with no permanent loss of transparency	Abrasion, staining, or discoloration (some permanent loss of transparency)	Cracking or pitting. Severe loss of transparency.	Fractured, lose, or missing sections.
Cracking (1010)	None.	Crack that has been arrested with effective countermeasures.	Identified crack that has not been arrested.	Identified crack that has fractured, or failure is eminent.
Connections (1020)	Connection in-place and functioning.	Loose fasteners, but connection is functioning.	Missing fasteners; broken welds; or pack rust with distortion.	Connection has failed or failure is eminent.
Deterioration (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown.	Severe deterioration or breakdown (or failure is eminent).
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation.	Condition warrants structural review.
Misalignment (Use 1900)	None	Slightly misaligned.	Significantly misaligned.	Severely misaligned.
Impact Damage (7000)	Superficial damage.	Minor to moderate impact damage.	Significant impact damage.	Members severely damaged, detached, or missing.

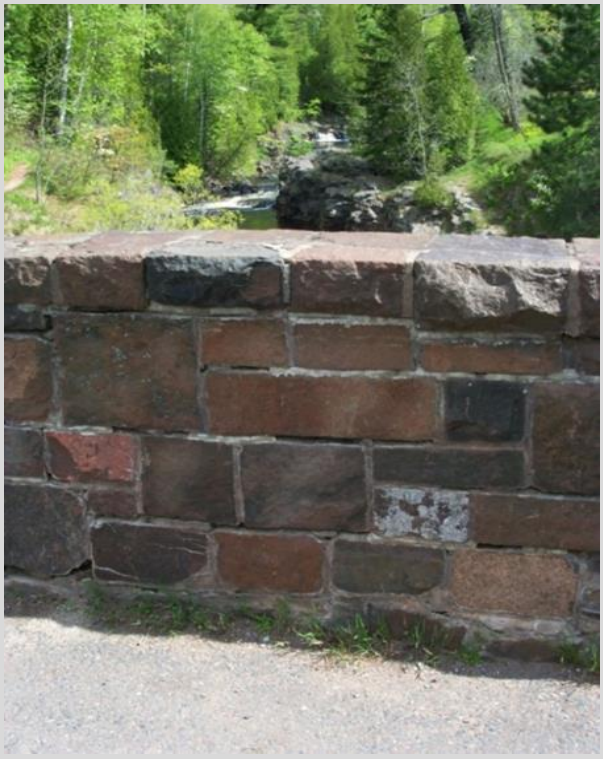
3.7.5 Masonry Bridge Railing (Element #334)

#334: Masonry Bridge Railing (LF)				
This element applies to all shapes or types of masonry bridge railing (block, brick, or stone). This includes railings constructed entirely of masonry, as well as the masonry portions of combination railings. The other components of a combination railing should be rated separately using the appropriate railing element (metal, concrete, or timber).				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** review of defects has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** review has determined that the defects impact strength or serviceability.
Delamination or Spall (1080)	None	Delamination. Spalling less than 10% loss of block thickness.	Spalling with 10% to 25% loss of block thickness.	Spalling with more than 25% loss of block thickness.
Efflorescence or Rust Staining (1120)	None	Surface white without build-up or leaching, without rust staining.	Heavy build-up with rust staining.	Severe leaching (concrete unsound).
Mortar Breakdown (1610)	None	Cracks or voids in less than 10% of the joints.	Cracks or voids in 10% to 25% of the joints.	Cracks or voids in more than 25% of the joints.
Spilt or Fracture (1620)	None	Block split (no continuation into adjacent courses).	Fractured through adjacent courses or block split with significant offset.	Fracture or split reduces stability of structure.
Repairs or Patched Areas (1630)	No repairs are present.	Existing repairs are in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Scaling or Abrasion	Minor surface deterioration.	Less than 10% loss of block thickness.	10% to 25% loss of block thickness.	More than 25% loss of block thickness.
Masonry Displacement (1640)	None	Block or stone slightly misaligned.	Block or stone significantly misaligned.	Block or stone is severely misaligned (or detached).
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation.	Condition warrants structural review.
Impact Damage (7000)	Superficial damage.	Minor to moderate impact damage.	Significant impact damage.	Block or stone severely damaged, displaced, or missing.

#334: Masonry Bridge Railing (LF)

Condition Rating Examples (Masonry Bridge Railing)

Condition State 2
Minor mortar breakdown on a masonry bridge railing



Condition State 3
Extensive mortar breakdown on a masonry bridge railing

Condition State 3
Block split on a masonry parapet

Condition State 4
Severe impact damage on a masonry railing

3.8 BRIDGE APPROACH ELEMENTS

SDDOT has five bridge roadway approach elements. The approach should provide a smooth transition for vehicles travelling on and off the bridge. In addition to material defects, bridge approaches should be inspected for settlement or undermining. Approach alignment and geometric issues should be addressed using the Approach Roadway Alignment Appraisal Rating (B.AP.01).

- **#320: Prestressed Concrete Approach Slab (SF)**
- **#321: Reinforced Concrete Approach Slab (SF)**
- **#870: Asphalt Concrete Approaches (SF)**
- **#872: Gravel Approaches (SF)**
- **#873: Sidewalk Approach Slabs (SF)**

Note: these elements are intended for vehicular bridges and should not be used for culverts or railroad bridges.

3.8.1 Concrete Approach Slab (Elements #321 and #873)

#321: Concrete Approach Slab (SF) #873: Sidewalk Approach Slabs (SF)				
This element applies to reinforced concrete bridge approach slabs or sidewalk approach slabs, regardless of wearing surface type. A bridge/sidewalk approach slab is typically a short (about 20 ft. long) reinforced concrete roadway paving/sidewalk segment adjacent to the bridge. The SF quantity typically includes the approach roadway width (curb-to-curb) from the abutment end block joint to the approach joint (end to end). The top hat of the sleeper slab should also be included in the approach quantity. If no relief joint is present, the quantity should include the area extending to the end of the approach slab, or to a construction joint that provides a logical termination point. Similar dimensions for sidewalk approach slabs.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Delamination, Spall, Patched Area (1080)	None	Delamination (not yet loose). Spall 1” or less deep **and** 6” or less in diameter. Repaired area is sound.	Loose delamination. Spall more than 1” deep **or** more than 6” diameter. Repaired area is unsound or distressed.	Loose delamination (safety hazard). Spalling greater than 3” deep. Full-depth failures present or imminent.
Exposed Reinforcement (1090)	None	Exposed without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Efflorescence, Water/Salt Saturation, Rust Staining or Leaching (1120)	None	Light leaching (little or no build-up) or light water saturation.	Heavy leaching (significant build-up or stalactites). Significant water/salt saturation. Rust stains indicating rebar corrosion.	Severe leaching or severe salt/water saturation (deck failure imminent).
Cracking and Pattern/Map Cracking (1130)	Insignificant cracks (less than 0.012”) or moderate width cracks that have been sealed.	Unsealed moderate (0.012” to 0.05”) width cracks. Unsealed moderate density pattern/map (spacing of greater than 1’ to 3’ on center) with moderate width cracking.	Wide (greater than 0.05” to 0.125”) cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1’ or less on center).	Severe (greater than 0.125”) cracks or full depth fractures. Deck failure may be imminent.

#321: Concrete Approach Slab (SF)
#873: Sidewalk Approach Slabs (SF)

This element applies to reinforced concrete bridge approach slabs or sidewalk approach slabs, regardless of wearing surface type. A bridge/sidewalk approach slab is typically a short (about 20 ft. long) reinforced concrete roadway paving/sidewalk segment adjacent to the bridge. The SF quantity typically includes the approach roadway width (curb-to-curb) from the abutment end block joint to the approach joint (end to end). The top hat of the sleeper slab should also be included in the approach quantity. If no relief joint is present, the quantity should include the area extending to the end of the approach slab, or to a construction joint that provides a logical termination point. Similar dimensions for sidewalk approach slabs.

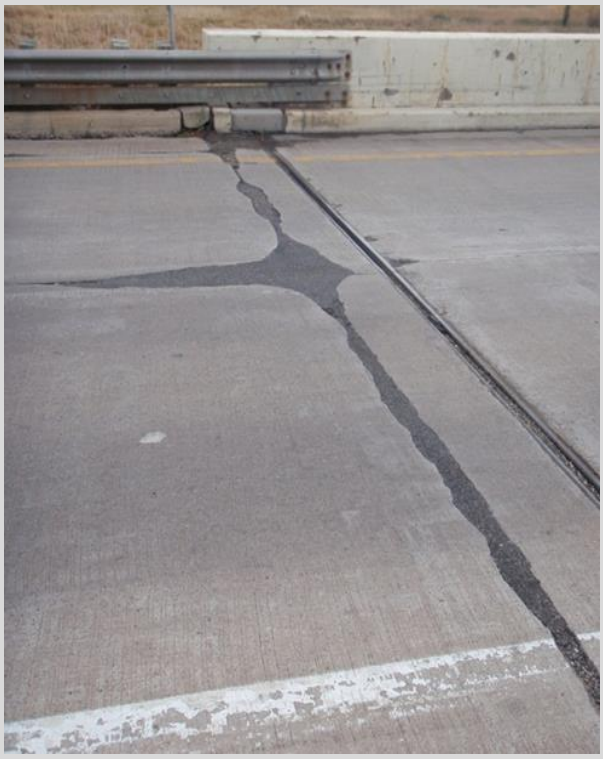
Item or Defect	Structural Element Condition States			
	1	2	3	4
	Good	Fair	Poor	Severe
Scale, Abrasion, or Wear (1190)	Superficial.	Coarse aggregate is exposed (½" deep or less) but remains secure in the concrete matrix.	Coarse aggregate is loose (greater than ½" to 3") or popped out of the concrete matrix.	Severe voiding (greater than 3") or **concrete** is unsound.
Settlement (4000)	None.	Exists within tolerable limits (less than 2" at greatest extent) or has been arrested with no observed structural distress.	Exceeds tolerable limits (2" up to 4").	Exceeds critical limits (greater than 4").
Damage (7000)	None.	Minor to moderate impact damage. Impact captured in condition state 2 under the appropriate defect.	Significant impact damage. Impact captured in condition state 3 under the appropriate defect.	Severe impact damage. Impact captured in condition state 4 under the appropriate defect.

- Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1' wide for ease of calculations and consistency.
- As a general rule, pattern or map cracked areas or areas with concentrated cracking can be documented and rated as a SF area.
- Approaches that have settled and had a temporary improvement (placing asphalt on the approach to even out the settlement) should be coded as the entire quantity in Condition State 3.

#321: Concrete Approach Slab (SF)
#873 Sidewalk Approach Slab (SF)

Condition Rating Examples (Concrete Approach Slab)

Condition State 2
Concrete patch on a concrete approach panel (along the end block joint)



Condition State 3
Temporary bituminous patch on a concrete approach panel (along the end block joint and centerline)

Condition State 4
Severe spall along centerline of a concrete approach panel

Condition State 4
Concrete approach panel fractured at the corner

3.8.2 Asphalt Concrete and Gravel Approach Roadways (Elements #870 and #872)

#870 Asphalt Concrete Approaches (SF) #872 Gravel Approaches (SF)				
These elements apply to roadways that terminate at the bridge abutments (with no underlying concrete slab). These are "square foot" items – there are quantities for each end of the bridge. If the bridge has a divided median or ramp, the quantity can be increased to rate each approach roadway segment separately. The area considered in the rating typically includes the approach roadway width or clear roadway width and extending out approximately 20 ft. from the end of the bridge deck.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
General Condition	Little or no deterioration.	Minor to moderate deterioration.	Extensive or significant deterioration – repairs may be required.	Severe deterioration – immediate repairs are required.
Potholes, Patching, or Repairs. (3210)	None.	Potholes less than ½" deep. Patches that remain sound.	Potholes ½" to less than 2" deep. Deteriorated patches or repairs.	Potholes 2" or deeper. Repair patches that have failed.
Wear or Rutting (Use 3230)	Minor wearing, no rutting.	Moderate wearing or minor rutting.	Significant wearing or rutting.	Severe wearing or rutting.
Cracking (3220)	Insignificant cracks	Moderate (1/4" to 1/2") unsealed cracks. Sealed cracks.	Significant (½" to 1½") unsealed cracks.	Severe (greater than 1½") unsealed cracks.
Bituminous Roadway (Use 3230)	Smooth and even with no potholes.	Moderate cracking or slight rutting.	Significant rutting or uneven surface.	Severe deterioration of the bituminous roadway (possible traffic hazard).
Gravel Roadway (Use 3230)	Evenly graded.	Moderately rutted or eroded.	Extensive rutting or erosion.	Severe deterioration of the gravel roadway (possible traffic hazard).
Settlement or Undermining (Use 3230)	No settlement or undermining – smooth transition on and off the bridge deck.	Slight settlement or undermining (traffic impact on the bridge has not been significantly increased).	Settlement has significantly increased traffic impact on the bridge. Significant undermining.	Settlement has severely increased traffic impact on the bridge. Severe undermining.

#870: Asphalt Concrete Approach (SF)
#872: Gravel Approach Roadway (SF)

Condition Rating Examples (Asphalt Concrete or Gravel Approach Roadways)

Condition State 2
Moderate deterioration on a bituminous approach roadway (cracking and patching)

Condition State 3
Extensive deterioration on a bituminous approach roadway (settlement, cracking, and patching)

Condition State 3
Significant settlement on a bituminous approach roadway (along the bridge deck)

Condition State 4
Severe washouts on a gravel approach roadway (traffic hazard)

3.8.3 Ride Quality of Approaches (Elements #875 and #876)

#875 Approach Smoothness Near the Beginning of the Bridge (Each) #876 Approach Smoothness Near the End of the Bridge (Each)				
The elements are used to code the worst condition state in any of the driving lanes for the approach adjacent to the bridge. These elements should only be looked at and used within 100 feet of the beginning or end of the bridge. • Element 875 is for the beginning (low MRM) of the bridge. • Element 876 is for the end (high MRM) of the bridge.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Smoothness (Use 4000)	No settlement. There is a smooth transition on and off the bridge.	Slight bump or settlement and minor impact to ride quality. **or** Slight to moderate movement of trucks over the area with possible minimal tire bounce/skip markings **and** no speed reduction.	Bump or settlement significantly impacts ride quality. **or** Significant movement of trucks over the area with possible substantial tire bounce/skip markings **and** no or minimal reduction in speed.	Bump or settlement is severe, may cause vehicle damage or accidents and must be addressed or repaired immediately. **or** Significant movement of trucks over the area with substantial tire bounce/skip markings **and** a moderate to large speed reduction and/or a bump sign in place.

#875: Approach Smoothness Near the Beginning of the Bridge (Each)
#876: Approach Smoothness Near the End of the Bridge (Each)

Condition Rating Examples

Condition State 2 (Concrete Approach Slab)
Slight to moderate movement of trucks with minimal skip markings

#875: Approach Smoothness Near the Beginning of the Bridge (Each)
#876: Approach Smoothness Near the End of the Bridge (Each)

Condition Rating Examples

Condition State 3 (Concrete Approach Slab)
Significant truck movement, substantial tire bounce/skip markings, slight speed reduction.

Condition State 4 (Concrete Approach Slab)
Significant truck movement, substantial tire bounce/skip markings, bump signs & speed reduction signs in place.

Condition State 2 (Concrete Approach Slab)
Slight truck movement and asphalt overlay repair of previously noted significant truck movement and speed reduction.

#875: Approach Smoothness Near the Beginning of the Bridge (Each)
#876: Approach Smoothness Near the End of the Bridge (Each)

Condition Rating Examples

Condition State 3 (Asphalt Approach)
Significant truck movement noted at the end of the bridge.

Condition State 3 (Asphalt Approach)
Significant truck movement noted at the end of the bridge.

Condition State 2 (Asphalt Approach)
Slight to moderate truck movement noted at the end of the bridge.

Condition State 2 (Asphalt Approach)
Slight to moderate truck movement noted and minimal tire bounce/skip marks at the beginning/end of the bridge.

3.9 SUPERSTRUCTURE AND SUBSTRUCTURE ELEMENTS

3.9.1 Steel Superstructure Elements

Steel Superstructure Elements	
#102: Steel Closed Web/Box Girder (LF) **#107: Steel Open Girder or Beam (LF)** **#113: Steel Stringer (LF)** **#120: Steel Truss (LF)**	**#141: Steel Arch (LF)** **#152: Steel Floor Beam (LF)** **#162: Steel Gusset Plate (Each)**
These elements apply to steel components of the bridge superstructure. This includes any steel type (weathering or non-weathering steel), and includes wrought iron. • Element #515, 815, 816, 817, or 818 (Steel Protective Coating) must be rated as a separate sub-element/protection system for each of these steel elements.	

Item or Defect	Condition States			
	1 Good	2 Fair	3 Poor	4 Severe
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Repairs	No repairs are present.	Existing repair in sound condition.	Repair recommended **or** existing repair is unsound.	Immediate repairs are required.
Corrosion (1000)	None	Surface corrosion (freckled rust) or corrosion has initiated.	Section loss, flaking rust, or pack rust is present.	Section loss exceeds 10% of the member cross section (or effective section).
Corrosion (Weathering Steel) (1000)	Initial layer of protective oxide coating.	Corrosion beyond the initial layer of protective oxide coating.		
Cracking (1010)	None.	Crack has self-arrested or has been arrested.	Un-arrested crack that is unlikely to propagate into a critical stress area.	Crack in a critical stress area (or may propagate into a critical stress area).
Connection (1020)	Connection in-place and functioning as intended.	Loose fasteners, but the connection is functioning as intended.	Missing bolts or rivets; broken welds; or pack rust with distortion.	Connection has failed (or failure is eminent).
Distortion (1900)	None	Mitigated distortion (or mitigation is not required).	Distortion requires mitigation and has not been addressed.	Severely bent or bowed.
Misalignment (Use 1900)	None	Slightly out of position or alignment.	Significantly out of proper position or alignment.	Severely out of proper position or alignment.
Damage (7000)	None.	Minor to moderate impact damage. Impact captured in condition state 2 under the appropriate defect.	Significant impact damage. Impact captured in condition state 3 under the appropriate defect.	Severe impact damage. Impact captured in condition state 4 under the appropriate defect.

Steel Superstructure Elements	
Condition Rating Examples (Steel Superstructure Elements)	
 **Condition State 1** **Unpainted weathering steel (initial protective layer of surface corrosion)**	 **Condition State 2** **Paint failure and surface corrosion on the bottom flange of a steel beam**
 **Condition State 2** **Extensive paint failure and surface corrosion on a steel girder**	 **Condition State 2** **Truss diagonal member reinforced with a bolted channel plate**

Steel Superstructure Elements	
Condition Rating Examples (Steel Superstructure Elements)	
 **Condition State 3** **Flaking rust (and pitting) in girder web at splice**	 **Condition State 3** **Pitting in girder web at splice (painted over)**
 **Condition State 3** **Pack rust along truss connection**	 **Condition State 4** **Large hole rusted through the web of a steel floor beam**

3.9.2 Steel Substructure Elements

Steel Substructure Elements				
#207: Steel Tower Trestle (LF) #219: Steel Abutment (LF)			**#231: Steel Pier/Bent Cap (LF)**	
These elements apply to steel components of the bridge substructure – this includes any steel type (weathering or non-weathering steel) and includes wrought iron. • If a steel substructure element is present on a bridge, Element #515, 815, 816, 817, or 818 (Steel Protective Coating) must be rated specifically for that element.				
Item or Defect	**Condition States**			
	1 Good	**2 Fair**	**3 Poor**	**4 Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Repairs	No repairs are present.	Existing repairs are in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Corrosion (1000)	None	Surface corrosion (freckled rust) or corrosion has initiated.	Section loss, flaking rust, or pack rust is present.	Section loss exceeds 10% of the member cross section (or effective section).
Cracking (1010)	None.	Crack has self-arrested or has been arrested.	Un-arrested crack that is unlikely to propagate into a critical stress area.	Crack in a critical stress area (or may propagate into a critical stress area).
Connection (1020)	Connection in-place and functioning as intended.	Loose fasteners, but the connection is functioning as intended.	Missing bolts or rivets; broken welds; or pack rust with distortion.	Connection has failed (or failure is eminent).
Distortion (1900)	None	Mitigated distortion (or mitigation is not required).	Distortion requires mitigation and has not been addressed.	Severely bent or bowed.
Settlement (4000)	None	Within tolerable limits or arrested (no structural distress).	Exceeds tolerable limits.	Stability of element has been reduced.
Scour (6000)	None	Within tolerable limits (or countermeasures installed).	Exceeds tolerable limits but is less than the critical scour limits.	Exceeds the critical scour limits.
Damage (7000)	None.	Minor to moderate impact damage. Impact captured in condition state 2 under the appropriate defect.	Significant impact damage. Impact captured in condition state 3 under the appropriate defect.	Severe impact damage. Impact captured in condition state 4 under the appropriate defect.

Steel Substructure Elements

Condition Rating Examples (Steel Substructure Elements)

Condition State 2
Paint failure and surface corrosion on a steel bearing cap

Condition State 2
Extensive paint failure and surface corrosion on a steel pier cap

Condition State 3
Flaking rust and pack rust on a steel bent cap

Condition State 4
Severe section loss (more than 10% of cross-section) on a steel pier cap

3.9.3 Steel Columns and Pilings

Steel Columns and Pilings				
#202: Steel Column (Each)			**#225: Steel or CIP Piling (Each)**	
These elements apply to steel columns or pilings of any steel type. These are "Each" quantities, so an overall condition state rating must be determined for each column or piling. Element #202 typically refers to vertical supports bearing on a concrete footing but could include the inclined legs on a steel K-frame. Element #225 refers specifically to piling that are driven into the ground. • If a steel column or piling element is present on a bridge, Element #515, 815, 816, 817, or 818 (Steel Protective Coating) may be rated specifically for that element. • #225 is typically only used when piling is exposed below a footing.				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Repairs	No repairs are present.	Existing repairs are in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Corrosion and Section Loss (1000)	None.	Surface corrosion (freckled rust). Section loss less than 1% of the total cross-section.	Flaking rust, or pack rust is present. Section loss less between 1% and 10% of the total cross-section.	Section loss exceeds 10% of the member cross section.
Cracking (1010)	None.	Crack has self-arrested or has been arrested.	Un-arrested crack that is unlikely to propagate into a critical stress area.	Crack in a critical stress area (or may propagate into a critical stress area).
Connection (1020)	In-place & functioning as intended.	Loose fasteners, but the connection is functioning as intended.	Missing bolts or rivets; broken welds; or pack rust with distortion.	Connection has failed (or failure is eminent).
Distortion (1900)	None	Mitigated distortion (or mitigation is not required).	Distortion requires mitigation and has not been addressed.	Severely bent or bowed.
Settlement (4000)	None	Within tolerable limits or arrested (no structural distress).	Exceeds tolerable limits.	Stability of element has been reduced.
Scour (6000)	None	Within tolerable limits (or countermeasures installed).	Exceeds tolerable limits but is less than the critical scour limits.	Exceeds the critical scour limits.
Damage (7000)	None.	Minor to moderate impact damage. Impact captured in CS 2 under the appropriate defect.	Significant impact damage. Impact captured in CS 3 under the appropriate defect.	Severe impact damage. Impact captured in CS 4 under the appropriate defect.

Steel Columns and Pilings	
Condition Rating Examples (Steel Columns and Pilings)	
 **Condition State 2** **Paint failure and surface corrosion on a CIP Pile**	 **Condition State 2** **Paint failure and surface corrosion on a steel column**
 **Condition State 2** **Impact damage (bent flange) on a steel H-pile**	 **Condition State 2** **Paint failure and surface corrosion on a pinned steel column**

Steel Columns and Pilings

Condition Rating Examples (Steel Columns and Pilings)

Condition State 3
Flaking rust (section loss) on a CIP Pile

Condition State 3
Flaking rust (section loss) on a steel H-Pile

Condition State 4
Severe corrosion and section loss on a steel h-pile

Condition State 4
Fracture in steel shell of a CIP Piling

3.9.4 Steel Protective Coatings (Elements #515, #815, #816, #817, and #818)

#515: Steel Protective Coating (SF) #815: Weathering Steel (SF) #816: Lead Based Paint (SF)	#817: Non-Lead Based Paint (SF) #818: Metallized/Galvanized Coating (SF)

If an NBE steel element (deck, railing, superstructure, substructure, or culvert) is present on a bridge, Element #515, 815, 816, 817, or 818 (Steel Protective Coating) should be rated as a sub-element/protection system for that steel element. Element #515, 815, 816, 817, or 818 is entered in BrM directly below each steel element.

The total surface area (in square feet) of each steel element must be determined. Portions of a steel element that are encased in concrete (such as the top surface of the top flange of a beam), should not be included in this quantity. For steel box members, this quantity will include the exterior and interior surfaces. This SF quantity may initially be entered as a rough estimate, but a more accurate quantity should eventually be calculated.

Item or Defect	Condition States			
	1 Good	2 Fair	3 Poor	4 Severe
Painted Steel Surfaces	Little or no paint deterioration.	Minor paint deterioration.	Finish coat failure – prime coat remains mostly intact.	Paint system failure. Steel exposed.
Chalking (3410)	None.	Light chalking and fading of finish coat.	Heavy chalking or loss of pigment.	NA
Peeling, Bubbling, Cracking (3420)	None.	Finish coat has peeling, bubbling, and cracking. Prime coat no issues.	Finish coat failure – prime coat starting to show issues but remains mostly intact.	Exposure of base metal.
Coating Loss Percentage (1 SF Coated Segment)	0.3% or less*	0.3% to 3%*	3% to 16%*	More than 16%*
	*Percentages are based upon The Society for Protective Coatings SSPC-VIS 2 (Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces)			
Galvanized Steel Surfaces (Use 3440)	Little or no deterioration of galvanized coating.	Minor coating deterioration.	Moderate coating deterioration (coating remains mostly intact).	Galvanized coating system failure.
Duplex Coated (Galvanized and Painted) Steel Surfaces	Little or no deterioration.	Minor coating deterioration.	Moderate coating deterioration – galv. coating remains mostly intact.	Extensive duplex coating system failure.
Unpainted Weathering Steel Surfaces (3430)	Protective oxide coating is uniform and tightly adhered (yellow, orange, or brown color)	Protective oxide coating is uneven or has minor deterioration. Dark brown color – the surface may be dusty or granular.	Protective oxide coating has moderate failure (small flakes, less than ½" diameter). Black color.	Protective oxide coating has failed. Large areas of the surface layer are flaking off.
Effectiveness (3440)	Fully effective.	Substantially effective.	Limited effectiveness.	Failed. Underlying metal exposed.

#515: Steel Protective Coating – Paint (SF)
#816: Lead Based Paint (SF)
#817: Non-Lead Based Paint (SF)

Condition Rating Examples (Protective Coatings – Paint)

Condition State 2
Chalking paint on steel arch bracing members.

Condition State 2
Minor paint failure (Isolated – less than 3%).

Condition State 3
Paint finish coat failure (primer coat remains intact).

Condition State 4
Paint system failure (exposed steel).

#515: Steel Protective Coating – Weathering Steel (SF)
#815: Weathering Steel (SF)

Condition Rating Examples (Protective Coatings – Weathering Steel)

Condition State 1
Weathering steel patina is uniform and tightly adhered to the steel beam.

Condition State 2
Weathering steel patina is slightly uneven – surface is granular and dusty.

Condition State 3
Weathering steel patina has flaking (less than ½" diameter) along the bottom flange.

Condition State 4
Weathering steel patina has failed – large areas of surface layer flaking off.

#515: Steel Protective Coating – Galvanized or Duplex (SF)
#818: Metallized/Galvanized Coating (SF)

Condition Rating Examples (Protective Coatings – Glanvanized or Duplex)

Condition State 2
Galvanized coating on bridge rail is faded.

Condition State 3
Finish paint coat (Duplex system) has been scraped off, the galvanized layer below remains intact.

Condition State 3
Finish paint coat (Duplex system) has extensive failure, the galvanized layer below remains intact.

Condition State 4
Complete failure of a Duplex system on a steel railing (isolated locations).

3.9.5 Reinforced Concrete Superstructure Elements

Reinforced Concrete Superstructure Elements				
#105: Reinforced Concrete Closed/Web Box Girder (LF) **#110: Reinforced Concrete Open Girder/Beam (LF)**			**#116: Reinforced Concrete Stringer (LF)** **#144: Reinforced Concrete Arch (LF)** **#155: Reinforced Concrete Floor Beam (LF)**	
These elements apply to structural members constructed of reinforced concrete (cast-in-place or pre-cast). These elements should not be used for prestressed or post-tensioned concrete.				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Delamination, Spall, or Patched Area (1080)	None	Delamination (not yet loose). Spall 1” or less deep **and** 6” or less in diameter. Existing repair in sound condition.	Loose delamination. Spall more than 1” deep **or** more than 6” diameter. Repairs are recommended **or** existing repair is unsound or distressed.	Loose delamination (safety hazard). Spalling greater than 3” deep. Full-depth failures present or imminent. Immediate repairs are required.
Exposed Reinforcement (1090)	None	Exposed without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Efflorescence, Rust Staining or Leaching (1120)	None	Surface white without build-up or light leaching (little or no build-up).	Heavy leaching (significant build-up or stalactites) or rust stains indicating rebar corrosion.	Severe leaching (concrete unsound).
Cracking and Pattern/Map Cracking (1130)	Insignificant cracks (less than 0.012”) or moderate width cracks that have been sealed.	Unsealed moderate (0.012” to 0.05”) width cracks. Unsealed moderate density pattern/map (spacing of greater than 1’ to 3’ on center) with moderate width cracking.	Wide (greater than 0.05” to 0.125”) cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1’ or less on center).	Severe (greater than 0.125”) cracks or full depth fractures. Failure may be plausible.
Scale, Abrasion, or Wear (1190)	Superficial.	Coarse aggregate is exposed (½” deep or less) but remains secure in the concrete matrix.	Coarse aggregate is loose (greater than ½” to 3”) or popped out of the concrete matrix.	Severe voiding (greater than 3”) or concrete is unsound.
Damage (7000)	Superficial scrapes.	Minor to moderate impact damage.	Significant impact damage.	Severe impact damage.
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1’ wide for ease of calculations and consistency. • As a general rule, pattern or map cracked areas or areas with concentrated cracking should be documented and are rated as a LF area – use engineering judgement.				

Reinforced Concrete Superstructure Elements	
Condition Rating Examples (Reinforced Concrete Superstructure Elements)	
 **Condition State 2** **Cracking on precast concrete channel beams.**	 **Condition State 2** **Patching on a concrete arch spandrel cap.**
 **Condition State 3** **Water saturation, rust staining, and spalling on a cast-in-place concrete T-girder.**	 **Condition State 3** **Cracking, delamination, and rust staining a precast concrete channel beam.**

Reinforced Concrete Superstructure Elements	
Condition Rating Examples (Reinforced Concrete Superstructure Elements)	
 **Condition State 3** **Spalling on a precast concrete tee beam.**	 **Condition State 3** **Spalling on a reinforced concrete arch.**
 **Condition State 4** **Severe spalling (and fracture) on a concrete arch spandrel wall.**	 **Condition State 4** **Severe impact damage (exposed and bent reinforcement) on a cast-in-place concrete T-girder.**

3.9.6 Reinforced Concrete Substructure Elements

Reinforced Concrete Substructure Elements				
#210: Reinforced Concrete Pier Wall (LF) **#220: Reinforced Concrete Footing (LF)** **#215: Reinforced Concrete Abutment (LF)** **#234: Reinforced Concrete Pier/Bent Cap (LF)**				
These elements apply to substructure members constructed of cast-in-place or pre-cast concrete.				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Delamination, Spall, or Patched Area (1080)	None	Delamination (not yet loose). Spall 1” or less deep **and** 6” or less in diameter. Existing repair in sound condition.	Loose delamination. Spall more than 1” deep **or** more than 6” diameter. Repairs are recommended **or** existing repair is unsound or distressed.	Loose delamination (safety hazard). Spalling greater than 3” deep. Full-depth failures present or imminent. Immediate repairs are required.
Exposed Reinforcement (1090)	None	Exposed without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Efflorescence, Rust Staining, or Leaching (1120)	None	Surface white without build-up or light leaching (little or no build-up).	Heavy leaching (significant build-up or stalactites) or rust stains indicating rebar corrosion.	Severe leaching (concrete unsound).
Cracking and Pattern/Map Cracking (1130)	Insignificant cracks (less than 0.012”) or moderate width cracks that have been sealed.	Unsealed moderate (0.012” to 0.05”) width cracks. Unsealed moderate density pattern/map (spacing of greater than 1’ to 3’ on center) with moderate width cracking.	Wide (greater than 0.05” to 0.125”) cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1’ or less on center).	Severe (greater than 0.125”) cracks or full depth fractures. Deck failure may be imminent.
Scale, Abrasion, or Wear (1190)	Superficial.	Coarse aggregate is exposed (½” deep or less) but remains secure in the concrete matrix.	Coarse aggregate is loose (greater than ½” to 3”) or popped out of the concrete matrix.	Severe voiding (greater than 3”) or concrete is unsound.
Misalignment	None	Slightly misaligned.	Significantly misaligned.	Severely misaligned.
Decorative Veneers	Superficial deterioration	Delaminated or deteriorated.	Missing or severely deteriorated.	Loose veneer poses a safety hazard.
Settlement (4000)	None	Within tolerable limits or arrested.	Exceeds tolerable limits.	Stability of element has been reduced.
Scour (6000)	None	Within tolerable limits or countermeasures installed.	Exceeds tolerable limits but less than critical scour limits.	Exceeds the critical scour limits.
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1’ wide for ease of calculations and consistency. • As a general rule, pattern or map cracked areas or areas with concentrated cracking should be documented and are rated as a LF area – use engineering judgement.				

Reinforced Concrete Substructure Elements

Condition Rating Examples (Reinforced Concrete Substructure Elements)

Condition State 2
Leaching crack in the parapet (back wall) on a reinforced concrete abutment.

Condition State 3
Shear crack (1/16″ or 0.06″ wide) in a reinforced concrete pier cap.

Condition State 3
Cracks with heavy leaching on a reinforced concrete abutment.

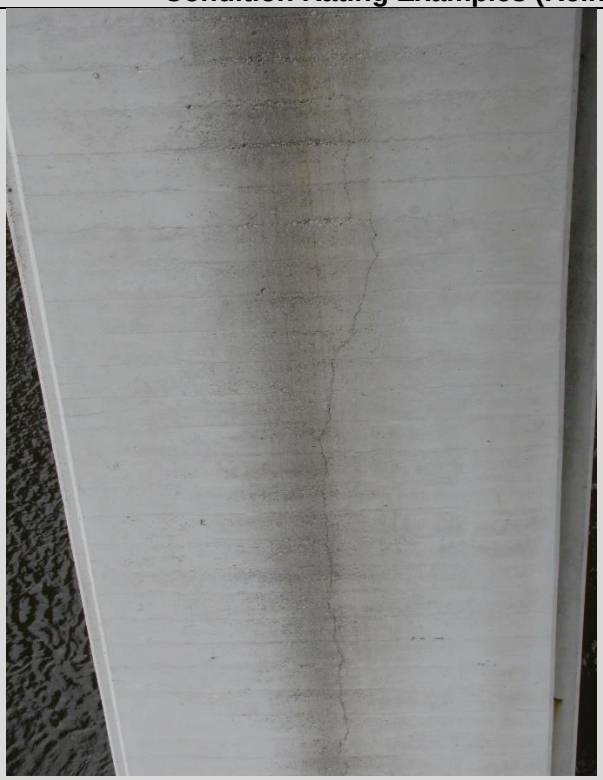
Condition State 3
Wide horizontal cracking with rust stains on the face of a reinforced concrete abutment.

Condition State 3
Spalling with exposed reinforcement and rust stains on a reinforced concrete pier cap.

Condition State 4
Severe spalling on a reinforced concrete pier cap.

3.9.7 Reinforced Concrete Columns and Pilings

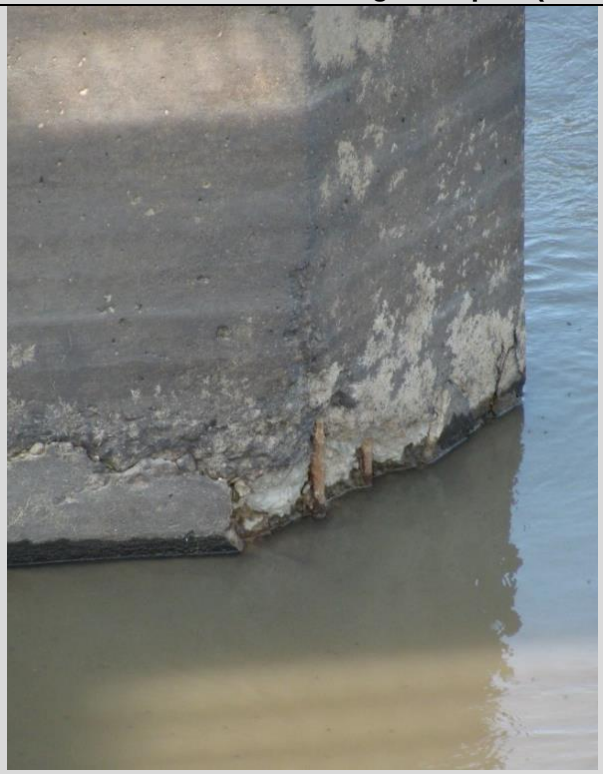
Reinforced Concrete Columns and Pilings				
#205: Reinforced Concrete Column (Each) **#227: Reinforced Concrete Piling (Each)**				
These elements apply to columns or pilings constructed of cast-in-place or pre-cast concrete. These are "Each" quantities, so an overall condition state rating must be determined for each column or piling present on the bridge. Element #227 (Concrete Piling) refers specifically to piling that are driven into the ground. Drilled shafts or caissons should be rated using Element 205 (Concrete Column)				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Loss of Cross-Section	None	Insignificant (less than 1%)	Moderate (from 1% to 10%)	Severe (more than 10%)
Delamination, Spall, or Patched Area (1080)	None	Delamination (not yet loose). Spall 1" or less deep **and** 6" or less in diameter. Existing repair in sound condition.	Spall more than 1" deep **or** more than 6" diameter. Repairs are recommended **or** existing repair is unsound or distressed.	Loose delamination (safety hazard). Spalling greater than 3" deep. Full-depth failures present or imminent. Immediate repairs are required.
Exposed Reinforcement (1090)	None	Exposed without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Efflorescence, Rust Staining, or Leaching (1120)	None	Surface white without build-up or light leaching (little or no build-up).	Heavy leaching (significant build-up or stalactites) or rust stains indicating rebar corrosion.	Severe leaching (concrete unsound).
Cracking and Pattern/Map Cracking (1130)	Insignificant cracks (less than 0.012") or moderate width cracks that have been sealed.	Unsealed moderate (0.012" to 0.05") width cracks. Unsealed moderate density pattern/map (spacing of greater than 1' to 3' on center) with moderate width cracking.	Wide (greater than 0.05" to 0.125") cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1' or less on center).	Severe (greater than 0.125") cracks or full depth fractures. Deck failure may be imminent.
Scale, Abrasion, or Wear (1190)	Superficial.	Coarse aggregate is exposed (½" deep or less) but remains secure in the concrete matrix.	Coarse aggregate is loose (greater than ½" to 3") or popped out of the concrete matrix.	Severe voiding (greater than 3") or concrete is unsound.
Misalignment	None	Slightly misaligned.	Significantly misaligned.	Severely misaligned.
Decorative Veneers	Superficial deterioration	Delaminated or deteriorated.	Missing or severely deteriorated.	Loose veneer poses a safety hazard.
Settlement (4000)	None	Within tolerable limits or arrested.	Exceeds tolerable limits.	Stability of element has been reduced.
Scour (6000)	None	Within tolerable limits or countermeasures installed.	Exceeds tolerable limits but less than critical scour limits.	Exceeds the critical scour limits.

Reinforced Concrete Columns and Pilings	
Condition Rating Examples (Reinforced Concrete Columns and Pilings)	
 **Condition State 2** **Moderate width vertical crack on a reinforced concrete column.**	 **Condition State 2** **Moderate map cracking on a reinforced concrete column.**
 **Condition State 2** **Isolated spall with exposed reinforcement on a reinforced concrete column.**	 **Condition State 2** **Isolated impact spall on a reinforced concrete column.**

Reinforced Concrete Columns and Pilings	
Condition Rating Examples (Reinforced Concrete Columns and Pilings)	
 **Condition State 2** **Isolated loose and missing stone veneer.**	 **Condition State 2** **Repair on a reinforced concrete column.**
 **Condition State 3** **Significant spall on a precast concrete pile.**	 **Condition State 3** **Spalling (exposed and corroded reinforcement) near the top of a reinforced concrete column.**

Reinforced Concrete Columns and Pilings

Condition Rating Examples (Reinforced Concrete Columns and Pilings)



Condition State 3
Significant scale/abrasion along the waterline on a reinforced concrete column.

Condition State 4
Extensive spalling (exposed and corroded reinforcement) on a reinforced concrete column.

Condition State 4
Severe scale/spall on a reinforced concrete pile.

Condition State 4
Severe spall on a reinforced concrete column.

3.9.8 Prestressed Concrete Superstructure Elements

Prestressed Concrete Superstructure Elements				
#104: Prestressed Concrete Closed Web/Box Girder (LF) #109: Prestressed Concrete Open Girder or Beam (LF)			**#115: Prestressed Concrete Stringer (LF) #143: Prestressed Concrete Arch (LF) #154: Prestressed Concrete Floor Beam (LF)**	
These elements apply to superstructure members constructed of either prestressed or post-tensioned concrete.				
• Element #104 (Prestressed Concrete Box Girder) includes the bottom flange and web walls of post-tensioned box girders. The top flange is rated separately using Element #15 (Prestressed Concrete Top Flange). • Element #109 (Prestressed Concrete Girder or Beam) includes the vertical portions of prestressed Bulb Tees, Double Tees, or Quad Tees. The horizontal portions are rated separately using Element #15 (Prestressed Concrete Top Flange).				
Item or Defect	**Condition States**			
	1 Good	**2 Fair**	**3 Poor**	**4 Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Delamination, Spall, Patched Area (1080)	None	Delamination (not yet loose). Spalling 1" or less deep **and** 6" or less in diameter. Existing repair in sound condition	Spalling greater than 1" deep **or** greater than 6" diameter. Repairs are recommended **or** existing repair is unsound.	Loose delamination (safety hazard). Spalling deeper than 3". Immediate repairs are required.
Exposed Rebar (1090)	None.	Exposed rebar without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Exposed Prestressing Strands (1100)	None	Exposed without section loss.	Exposed with corrosion or section loss (not severed).	Exposed with severe section loss (or severed).
Cracking and Pattern/Map Cracking (1110)	Insignificant cracks (less than 0.004") or moderate width cracks that have been sealed.	Unsealed moderate (0.004" to 0.009") width cracks. Unsealed moderate density pattern/map (spacing of greater than 1' to 3' on center) with moderate width cracking.	Wide (greater than 0.009" to 0.02") cracks. Heavy density pattern/map with unsealed moderate width cracking or greater (spacing of 1' or less on center).	Severe (greater than 0.02") cracks or full depth fractures. Failure may be plausible.
Efflorescence, Water/Salt Saturation, Rust Staining or Leaching (1120)	None	Light leaching (little or no build-up) or light water saturation.	Heavy leaching (significant build-up or stalactites). Significant water/salt saturation. Rust stains indicating rebar corrosion.	Severe leaching or severe salt/water saturation (failure imminent).
Damage (7000)	Superficial scrapes.	Minor to moderate impact damage.	Significant impact damage.	Severe impact damage.
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1' wide for ease of calculations and consistency. • As a general rule, pattern or map cracked areas or areas with concentrated cracking should be documented and are rated as a LF area – use engineering judgement.				

Prestressed Concrete Superstructure Elements	
Condition Rating Examples (Prestressed Concrete Superstructure Elements)	
 **Condition State 2** **Impact damage (minor spall) on a prestressed concrete beam.**	 **Condition State 2** **Draped strand cracking in the end a prestressed concrete beam.**
 **Condition State 3** **Spalling on the web of a prestressed concrete beam.**	 **Condition State 3** **Spalling on a bottom flange of a prestressed concrete beam.**

Prestressed Concrete Superstructure Elements	
Condition Rating Examples (Prestressed Concrete Superstructure Elements)	
 **Condition State 3** **Scale/spall on the fascia of a prestressed concrete box beam.**	 **Condition State 3** **Impact damage (spalling) on a post-tensioned concrete beam.**
 **Condition State 4** **Severe spall and strand corrosion on a post-tensioned box girder.**	 **Condition State 4** **Severe impact damage on a prestressed concrete beam.**

3.9.9 Prestressed Concrete Substructure Elements

Prestressed Concrete Substructure Elements				
#204: Prestressed Concrete Column (Each) #226: Prestressed Concrete Piling (Each) #233: Prestressed Concrete Pier/Bent Cap (LF)				
These elements apply to substructure members comprised of prestressed or post-tensioned concrete.				
Item or Defect	**Condition States**			
	1 Good	**2 Fair**	**3 Poor**	**4 Severe**
Structural Review	Structural review is not required.		Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Delamination, Spall, Patched Area (1080)	None.	Delamination (not yet loose). Spalling 1" or less deep **and** 6" or less in diameter. Existing repair in sound condition	Spalling greater than 1" deep **or** greater than 6" diameter. Repairs are recommended **or** existing repair is unsound.	Loose delamination (safety hazard). Spalling deeper than 3" or rebar with severe section loss. Immediate repairs are required.
Exposed Rebar (1090)	None.	Exposed rebar without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Exposed Prestressing Strands (1100)	None	Exposed without section loss.	Exposed with corrosion or section loss (not severed).	Exposed with severe section loss (or severed).
Cracking and Map (Pattern) Cracking (1110)	Insignificant cracks (less than 0.004") or moderate width cracks that have been sealed.	Unsealed moderate (0.004" to 0.009") width cracks or unsealed moderate pattern/map (spacing of 1-3' on center) cracking.	Wide (greater than 0.009" to 0.02") cracks. Heavy pattern/map (spacing of 1' or less on center) cracking.	Severe (greater than 0.02") cracks or full depth fractures. Deck failure may be imminent.
Efflorescence, Leaching, or Rust Staining (1120)	None.	Light leaching (little or no build-up). Light water saturation. Minor rust stains.	Heavy build-up or stalactites. Significant water/salt saturation. Rust stains indicating rebar corrosion.	Severe leaching (failure imminent), Severe salt/water saturation.
Misalignment	None.	Slightly misaligned.	Significantly misaligned.	Severely misaligned.
Settlement (4000)	None.	Within tolerable limits or arrested.	Exceeds tolerable limits.	Stability of element has been reduced.
Scour (6000)	None.	Within tolerable limits or countermeasures installed.	Exceeds tolerable limits but less than critical scour limits.	Exceeds the critical scour limits.
• Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1' wide for ease of calculations and consistency. • As a general rule, pattern or map cracked areas or areas with concentrated cracking should be documented and are rated as a LF area – use engineering judgement.				

Prestressed Concrete Substructure Elements

Condition Rating Examples (Prestressed Concrete Substructure Elements)

Condition State 1
Post-tensioned pier cap with no defects.

Condition State 2
Cracking on the face of a post-tensioned pier cap.

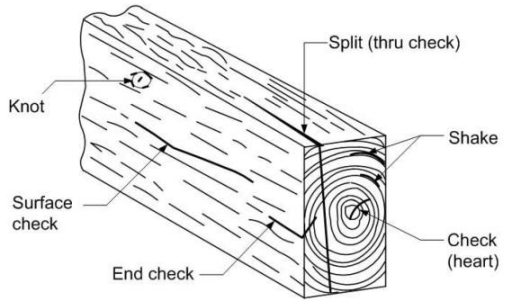
Condition State 3
Spalled end cap on a post-tensioned concrete pier cap.

Condition State 4
Severe spalling on a prestressed concrete pile.

3.9.10 Timber Superstructure Elements

Timber Superstructure Elements				
#111: Timber Open Girder or Beam (LF) **#117: Timber Stringer (LF)** **#135: Timber Truss (LF)**			**#146: Timber Arch (LF)** **#156: Timber Floor Beam (LF)**	
These elements apply to timber superstructure members of any type or shape. This includes sawn or glue-lam timber members. Connections on timber elements will typically include steel components (bolts, nuts, washers, connection plates, etc.).				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.		Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Repairs	No repairs are present.	Existing repair in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Connection (1020)	Connection in-place and functioning as intended.	Loose fasteners, but connection is functioning as intended.	Missing bolts, rivets, or fasteners, broken welds, or pack rust with distortion.	Connection has failed (or failure is eminent).
Decay, Abrasion, or Fire Damage (1140)	Minor deterioration (no section loss).	Less than 10% section loss. No crushing or sagging.	More than 10% section loss. Some crushing or sagging.	More than 10% section loss & warrants review. Severe crushing or sagging.
Shakes, Checks, or Splits (1150 or 1170)	Penetrating less than 5% of the member thickness.	Penetrates 5% to 50% of the member thickness (not in a tension zone).	Penetrates more than 50% of the member thickness or more than 5% of the member thickness in a tension zone.	Penetrates through entire member or more than 25% of the member thickness in a tension zone.
Crack (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that has not been arrested and does not require structural review.	Severe cracks or full depth fractures. Failure may be plausible.
Delamination - Glulam (1170)	None.	Minor.	Significant.	Severe.
Misalignment	None.	Slightly misaligned.	Significantly misaligned.	Severely misaligned.
Damage (7000)	Superficial scrapes.	Minor to moderate impact damage.	Significant impact damage.	Severe impact damage.

- **Shake:** A separation along the grain (between the growth rings). Usually forms within a standing tree or during felling.
- **Check:** A separation perpendicular to the grain (across the growth rings). Usually results from stress due to drying shrinkage.
- **Split (or Thru Check):** A check extending further through the timber member due to tearing apart of wood cells.



Timber Superstructure Elements

Condition Rating Examples (Timber Superstructure Elements)

Condition State 2
Moderate horizontal splitting on a sawn timber beam.

Condition State 2
Minor impact damage on a glulam timber beam.

Condition State 3
Significant horizontal splitting on a sawn timber beam.

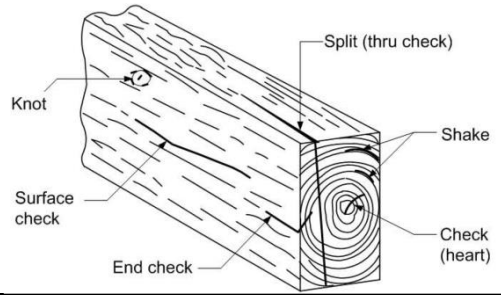
Condition State 3
Horizontal splitting with internal decay (plant growth) on a sawn timber beam.

Timber Superstructure Elements	
Condition Rating Examples (Timber Superstructure Elements)	
 **Condition State 3** **Fire damage on a sawn timber beam.**	 **Condition State 3** **Sawn timber beam fractured at pier bearing.**
 **Condition State 4** **Severe internal decay on a sawn timber beam.**	 **Condition State 4** **Severe crushing (failure) of a sawn timber beam.**

3.9.11 Timber Substructure Elements

Timber Substructure Elements				
#206: Timber Columns (Each) #208: Timber Trestle Tower (LF) #212: Timber Pier Wall (LF)			**#216: Timber Abutment (LF) #228: Timber Pile (Each) #235: Timber Pier/Bearing Cap (LF)**	
These elements apply to timber substructure members of any type or shape.				
Item or Defect	**Condition States**			
	1 Good	**2 Fair**	**3 Poor**	**4 Severe**
Structural Review	Structural review is not required.		Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Repairs	No repairs are present.	Existing repair in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Connection (1020)	In-place and functioning as intended.	Loose fasteners but functioning as intended.	Missing fasteners, connection is distressed.	Connection has failed (or failure is eminent).
Decay, Abrasion, or Fire Damage (1140 or 1180)	Minor deterioration (no section loss).	Less than 10% section loss. No crushing or sagging.	More than 10% section loss. Some crushing or sagging.	More than 10% section loss and warrants review. Severe crushing or sagging.
Shakes, Checks, or Splits (1150 or 1170)	Penetrates less than 5% of member thickness.	Penetrates 5% to 50% of member thickness and not in a tension zone.	Penetrates more than 50% of member thickness (or more than 5% in a tension zone).	Penetrates through entire member (or more than 25% in a tension zone).
Crack (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that has not been arrested and does not require structural review.	Severe cracks or full depth fractures. Failure may be plausible.
Misalignment	None	Slightly misaligned.	Significantly misaligned.	Severely misaligned.
Settlement (4000)	None	Within tolerable limits or arrested.	Exceeds tolerable limits.	Stability of element has been reduced.
Scour (6000)	None	Within tolerable limits or countermeasures installed.	Exceeds tolerable limits but less than critical scour limits.	Exceeds the critical scour limits.
Damage (7000)	Superficial scrapes.	Minor to moderate impact damage.	Significant impact damage.	Severe impact damage.

- **Shake:** A separation along the grain (between the growth rings). Usually forms within a standing tree or during felling.
- **Check:** A separation perpendicular to the grain (across the growth rings). Usually results from stress due to drying shrinkage.
- **Split (or Thru Check):** A check extending further through the timber member due to tearing apart of wood cells.



Timber Substructure Elements

Condition Rating Examples (Timber Substructure Elements)

Condition State 2
Checking on the end of a timber pier cap.

Condition State 2
Timber piling with decay at water line (less than 10% section loss).

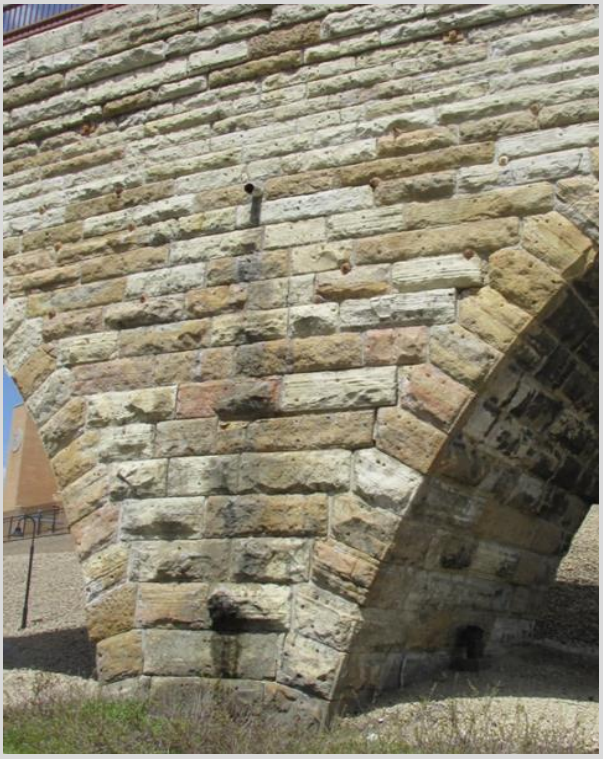
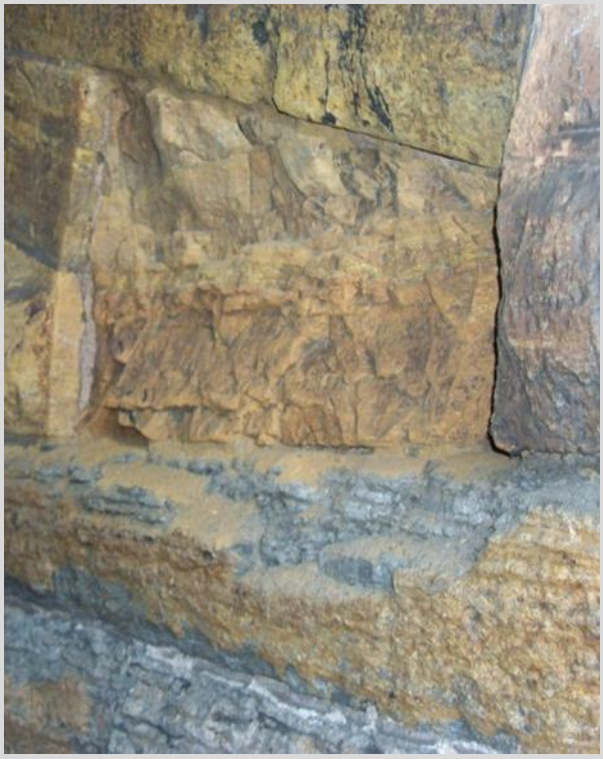
Condition State 3
Shell damage on a timber piling (section loss less than 10%).

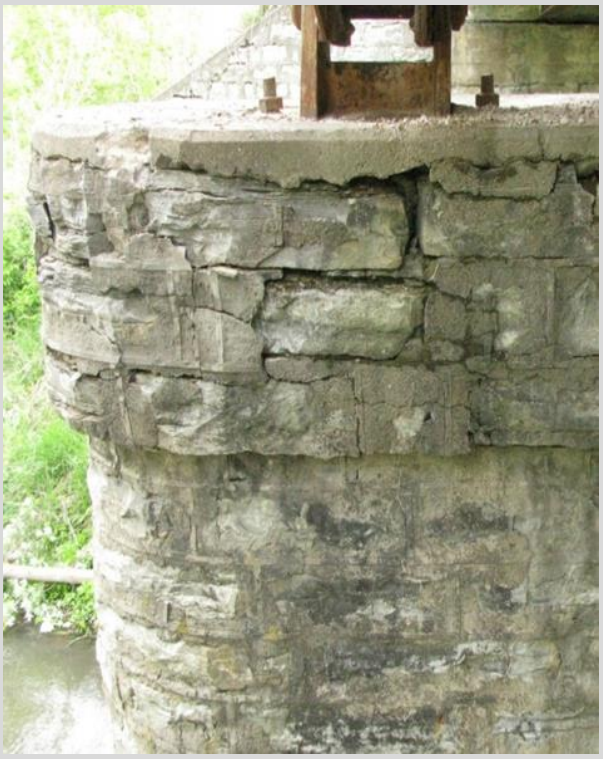
Condition State 3
Fire damage on a timber piling (section loss between less than 10%).

Timber Substructure Elements	
Condition Rating Examples (Timber Substructure Elements)	
 **Condition State 3** **Timber pile with splitting and decay at a bracing connection.**	 **Condition State 3** **Timber cap with significant misalignment (tipped) – not bearing fully on the steel piling.**
 **Condition State 4** **Failure of abutment backing planks.**	 **Condition State 4** **Timber pile with severe decay and crushing.**

3.9.12 Masonry Superstructure and Substructure Elements

Masonry Superstructure and Substructure Elements				
#145: Masonry Arch (LF) #213: Masonry Pier Wall (LF) #217: Masonry Abutment (LF)				
These elements apply to structural bridge components comprised primarily of masonry units. Masonry structures that have reinforced concrete components (that cannot be conveniently broken into separate elements) may be rated using masonry elements – use the reinforced concrete defect language to rate those areas. ***Note: These elements should not be used for masonry arch structures that are classified as "culverts" – use Element #244 (Masonry Culvert) instead.***				
Defects	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.		Structural review is not required **or** structural review has determined that the strength of the element has not been impacted.	Condition warrants structural review **or** structural review has determined that the strength of the element has been reduced.
Delamination or Spall (1080)	None	Delamination. Spalling less than 10% loss of block thickness.	Spalling with 10% to 25% loss of block thickness.	Spalling with more than 25% loss of block thickness.
Efflorescence or Rust Staining (1120)	None	Surface white without build-up or leaching, without rust staining.	Heavy build-up with rust staining.	Severe leaching (concrete unsound).
Mortar Breakdown (1610)	None	Cracks or voids in less than 10% of the joints.	Cracks or voids in 10% to 25% of the joints.	Cracks or voids in more than 25% of the joints.
Spilt or Fracture (1620)	None	Block split (no continuation into adjacent courses).	Fractured through adjacent courses or block split with significant offset.	Fracture or split reduces stability of structure.
Repairs or Patched Areas (1630)	No repairs are present.	Existing repairs are in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Scaling or Abrasion	Minor surface deterioration.	Less than 10% loss of block thickness.	10% to 25% loss of block thickness.	More than 25% loss of block thickness.
Masonry Displacement (1640)	None	Block or stone slightly misaligned.	Block or stone significantly misaligned.	Block or stone is severely misaligned (or detached).
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation.	Condition warrants structural review.
Settlement (4000)	None	Within tolerable limits or arrested.	Exceeds tolerable limits.	Stability of element has been reduced.
Scour (6000)	None	Within tolerable limits or countermeasures installed.	Exceeds tolerable limits but less than critical scour limits.	Exceeds the critical scour limits.

Masonry Superstructure and Substructure Elements	
Condition Rating Examples (Masonry Superstructure and Substructure Elements)	
 **Condition State 2** **Staining and scaling (minor section loss) on a masonry arch.**	 **Condition State 2** **Concrete repairs on a masonry arch.**
 **Condition State 3** **Fracture in a masonry block continuing into adjacent courses.**	 **Condition State 3** **Spalling on a masonry arch block (10% to 25% of block thickness).**

Masonry Superstructure and Substructure Elements	
Condition Rating Examples (Masonry Superstructure and Substructure Elements)	
 **Condition State 3** **Extensive mortar loss on a masonry arch.**	 **Condition State 3** **Leaching through joints on a masonry arch.**
 **Condition State 4** **Masonry pier wall severely deteriorated below a truss bearing.**	 **Condition State 4** **Masonry pier wall severely damaged by scour.**

3.10 BEARINGS & SPECIAL FEATURE ELEMENTS

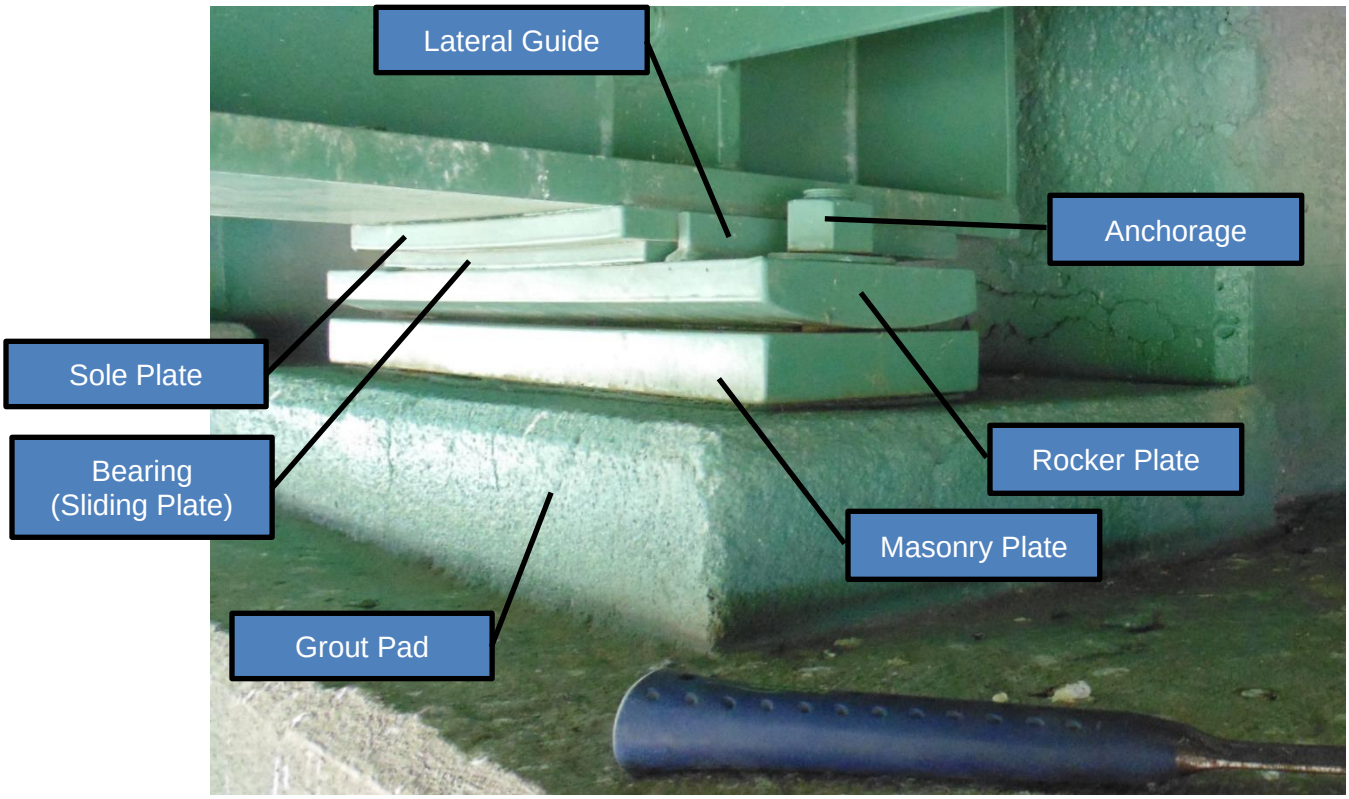
3.10.1 Bearing Components and Inspection Procedures

The primary function of a bearing is to transmit loads from the superstructure to the substructure. There are two basic types of bearings, expansion and fixed.

- Expansion bearings permit longitudinal movement of the superstructure due to thermal expansion and contraction. Most expansion bearings allow for rotation of the superstructure due to live load deflection. Some expansion bearings are designed to restrict lateral movement or to prevent uplift of the superstructure.
- Fixed bearings resist longitudinal movement of the superstructure due to thermal expansion and contraction. Most fixed bearings allow for rotation of the superstructure due to live load deflection, and to resist lateral movement of the superstructure.

A typical bearing assembly consists of the following components.

- **Sole Plate:** The sole plate protects the superstructure member, and transfers load from the superstructure to the bearing.
- **Bearing Device:** The bearing transfers load from the sole plate to the masonry plate. Bearings may incorporate sliding plates, rollers, rockers, pins, or elastomeric pads to allow for longitudinal or rotational movement of the superstructure.
- **Masonry Plate:** The masonry plate distributes load from the bearing to the supporting substructure unit (abutment, pier, or footing). Some bearings bear directly upon the bearing seat and others may bear on preformed cotton duck or other pads.
- **Anchorage:** Bearings that resist longitudinal or lateral movement (or uplift forces) require an anchorage system. This typically consists of threaded steel rods drilled (or cast) into the substructure unit.
- **Lateral Guide System:** Some expansion bearing assemblies include guides to prevent lateral movement while still allowing longitudinal expansion or contraction.



Inspection and Condition Rating of Bridge Bearings

Bearings should be examined for deterioration, function, alignment, as well as the soundness of the anchorage and substructure support. All of these factors should be taken into consideration when rating a bearing element. SDDOT uses seven bearing elements, the bridge design plans may need to be referenced to verify the type and quantity of bearing elements.

- **#310 - Elastomeric Bearing (Each)**
- **#311 - Movable or Expansion Bearing (Each)**
- **#312 - Enclosed/Concealed Bearing (Each)**
- **#313 - Fixed Bearing (Each)**
- **#314 - Pot Bearing (Each)**
- **#315 - Disk Bearing (Each)**
- **#316 - Other Bearing (Each)**

The importance of inspecting and maintaining bridge bearings should not be underestimated. If ignored, seemingly minor bearing problems could result in serious structural issues.

- Bearing malfunction can damage adjacent structural elements.
- Severe bearing misalignment often indicates significant problems elsewhere on the bridge (such as substructure settlement, shifting, or tipping).
- Loss of bearing area could result in collapse of a bridge span.

The 2005 collapse of the Dunn Bridge in Albany, New York was attributed to the malfunction of the rocker bearings, combined with horizontal deflection of the supporting pier. The rocker bearings had been misaligned for several years prior to the collapse.

Bearing Malfunction: A common problem with expansion bearings is seizing due to corrosion or debris. Bearings are typically located below deck joints, a highly corrosive environment. Debris (such as sand, dirt, and flaking rust) can restrict expansion, accelerate corrosion, increase wear, and prevent adequate inspection. Sliding plate, roller, and rocker bearings provide numerous locations for debris and moisture to collect. Expansion bearings should be examined for obvious evidence of recent movement (such as scraped paint, wear, or fretting rust). The inspector should take bearing measurements, and examine adjacent components (such as deck joints, railings, or curb plates) for evidence of recent expansion or contraction. Bearing malfunction can also result from bearing components that are worn, misaligned, broken, loose, or missing. Contact surfaces (plates, rollers, rockers, and pins) should be examined for wear and freedom of movement. Loose bearing components may be identified by noise (or movement) when the bridge is subjected to live loads.

Severe malfunction of an elastomeric bearing

Fixed pin truss bearing with severe loss of bearing area

Corroded (possibly frozen) sliding plate bearing

Bearings – Thermal Expansion and Contraction: The magnitude of the longitudinal movement of a bridge is dependent upon three factors – the coefficient of thermal expansion (steel and concrete are similar), the temperature range, and the structure length. As temperatures in South Dakota range from -30° F up to 120° F, a bridge bearing must be able to accommodate about 1-1/8" of longitudinal movement for every 100 ft. of structure length. Expansion bearings are typically designed to be in the neutral (centered) position at around 40° F.

Expansion bearings should be periodically measured to ensure that they are functioning as intended. The horizontal (longitudinal) distance from the neutral alignment should be recorded. Bearing measurements should be taken to the nearest 1/8", and the substrate temperature at the time of the measurement should be recorded. Thermal expansion or contraction which exceeds the bearing design limits can result in bearing failure – sliding plates may tip and lock, or rocker bearings may bind. The adjacent deck, superstructure, and substructure should be examined for contacting surfaces that might be preventing proper expansion.

Bearings - Lateral Movement and Uplift: Expansion bearings are often restrained from lateral movement by guide tabs, keeper bars, pintles, pin caps, or other mechanisms. Lateral guides should be examined for binding, particularly on skewed or curved bridges. Keeper bars on roller bearings can seize due to corrosion or debris – keeper bar failure could result in misalignment of rollers. Pintles that are exposed or sheared off may indicate excessive longitudinal movement.

Lateral restraint is sometimes provided by shear keys, shear lugs, or other devices that are incorporated into end diaphragms or floor beams. Lateral restraint systems separate from the bridge bearings should be noted in the bridge report.

Some bearings are also designed to resist uplift of the bridge superstructure – uplift forces may be present on curved bridges, anchor spans, steel pier caps, steel arch bridges, or on short end spans of continuous bridges. An uplift restraint system may consist of tension members such as anchor bolts or eye bars or may incorporate a counterweight. Uplift restraints should be examined for section loss, cracking, binding, or connection failure. Anchor bolts may require periodic ultrasonic examination.

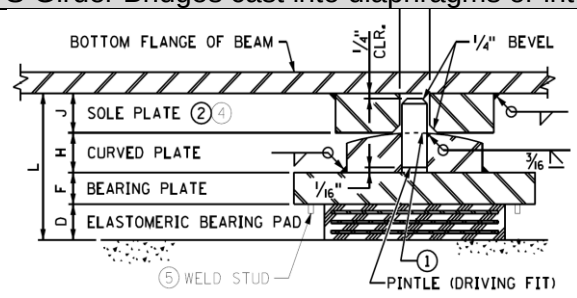
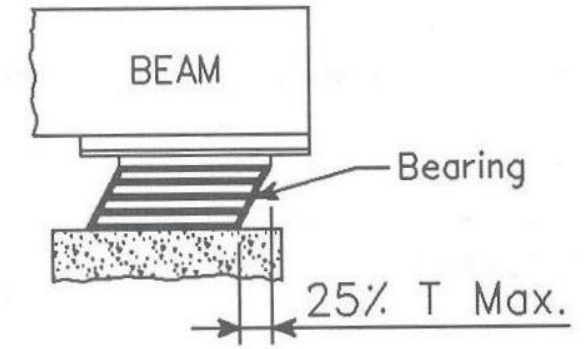
Sliding plate bearing near the design limits of expansion

Uplift (gap) on a curved plate fixed bearing

Anchor bolt failure on a fixed bearing

Bearings - Seats and Anchor Bolts: The bearing seats and anchor bolts should be examined for any evidence of deterioration or distress. Cracking or spalling of the bearing seat may indicate bearing anchorage failure – deterioration of the bearing seat can eventually result in loss of bearing area. Anchor bolts that are bent (or contacting the ends of slotted plates) may indicate excessive expansion or substructure movement. The position of bearing masonry plates should be measured and compared to the original plans, as they are sometimes reset due to substructure movement. Look for any evidence that the anchor bolts were not properly installed, such as bolts extending up too high or nuts not properly tightened.

3.10.2 Elastomeric Expansion Bearing (Element #310)

#310: Elastomeric Expansion Bearing (Each)	
This element applies to elastomeric bearing pads that facilitate expansion by deformation. These bearings may include steel plates above or below the elastomeric pads. *Not the temporary ones on PS Girder Bridges cast into diaphragms or integral abutments.	
	The pads are comprised of alternating layers of elastomer (100% virgin chloroprene) and 1/8" thick steel plates, which are bonded together and covered. Older elastomeric bearing pads may have fiberglass plates or may be solid neoprene (with no internal reinforcement).
	A curved steel pintle plate is usually placed on top of elastomeric pads to allow rotation due to deflection. The pintles fit into a sole plate attached to the bottom flange of the beam. The pintle plate at left has small weldments on the underside to keep the pad from "walking". Older elastomeric bearings may not have a pintle plate. Some elastomeric expansion bearings are restrained against lateral movement or uplift forces.
	Elastomeric bearings can accommodate longitudinal movement up to approximately 25% of the pad thickness – the longer the span, the thicker the pad required. While the pad deformation and orientation should correspond with the current temperature, the actual "neutral" position is the temperature when the bearing was installed. Example, a pad installed on a very hot day may always appear to be tipped in contraction.
	Elastomeric bearings generally require less maintenance than mechanical expansion bearings, as they are less susceptible to debris and corrosion. Elastomeric pads should be examined for excessive bulging, as well as splitting or tearing that expose the internal reinforcement plates.
	Elastomeric pads have a tendency to "walk" out from beneath the upper plate. Any significant misalignment should be measured, noted, and monitored during future inspections. Newer elastomeric bearings incorporate welded guides on the underside of the sole plate to keep them in position.

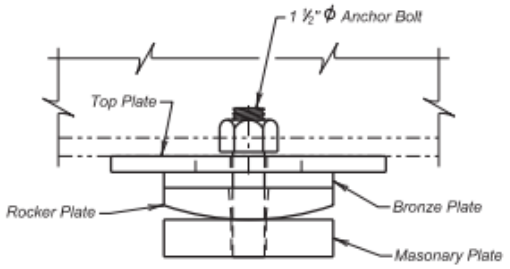
#310: Elastomeric Expansion Bearing (Each)				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Bearing Movement & Structural Review	Free to move.	Minor restriction.	Restricted but not warranting structural review (no immediate structural concern).	Severe restriction - structural review is warranted. **or** resetting, repair, or replacement required.
Corrosion (1000)	None.	Freckled rust (corrosion has initiated).	Section loss or pack rust is present.	Section loss severely impacts bearing function or capacity.
Alignment or Deformation (2220)	Alignment is appropriate for the current temperature.	Alignment is inconsistent for the current temperature.	Deformation is near design limits (25% of pad thickness).	Deformation is beyond design limits (25% of pad thickness).
Bearing Pad Position	Pad is properly positioned.	Pad has moved slightly (less than ½" beyond sole plate).	Pad has moved ½" to 2" beyond sole plate – resetting recommended.	Pad has moved more than 2" beyond sole plate – resetting required.
Bulging, Splitting or Tearing (2230)	None.	Bulging less than 15% of pad thickness. Minor rolling along pad edges.	Bulging more than 15% of pad thickness. Splitting or tearing (internal plates exposed). Significant rolling along pad edges. Pad surfaces are not parallel.	Splitting, bulging, de-bonding, or pad damage that severely impacts bearing function or capacity
Plates, Restraints, or Anchor Bolts	Plates, restraints, or anchor bolts are sound, properly positioned, and functioning.	Anchor nuts loose or missing (bolts remain intact). Plates slightly misaligned. Restraint system is functioning.	Anchor bolts loose, bent or at expansion limits. Plates significantly misaligned. Welds broken. Restraints not functioning.	Anchorage or restraint failure has severely impacted bearing function or capacity. Plates severely misaligned.
Loss of Bearing Area (2240)	None.	Less than 10%	10% to 25%	More than 25%

#310: Elastomeric Expansion Bearing (Each)	
Condition Rating Examples (Elastomeric Expansion Bearings)	
 **Condition State 2** **Elastomeric pads tipped in opposite directions.**	 **Condition State 2** **Pad rolled up slightly on the bottom edge and moved from beneath sole plate (less than ½").**
 **Condition State 3** **Pad has moved out from beneath the sole plate (more than ½" but less than 2").**	 **Condition State 3** **Pad covering torn, internal plates rusting.**
 **Condition State 4** **Pad has moved from beneath the curved pintle plate (nearly fallen off).**	 **Condition State 4** **Pad has moved from beneath the curved pintle plate (nearly fallen off).**

3.10.3 Movable or Expansion Bearing (Element #311)

#311: Movable or Expansion Bearing (Each)

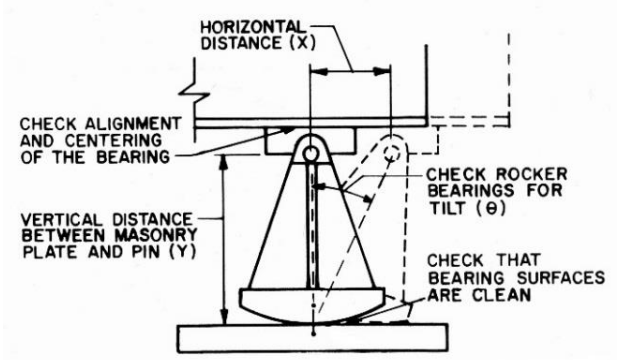
This element applies to mechanical expansion bearings of any type – such as sliding plate bearings, roller bearings, or rocker bearings. Expansion bearings allow for longitudinal movement of the superstructure due to thermal expansion and contraction. Most expansion bearings allow rotation of the superstructure due to live load deflection – some may be designed to restrict lateral movement or uplift forces.



Sliding plate bearings allow longitudinal movement by one steel plate sliding upon another (a curved pintle plate is sometimes included to allow for rotation).

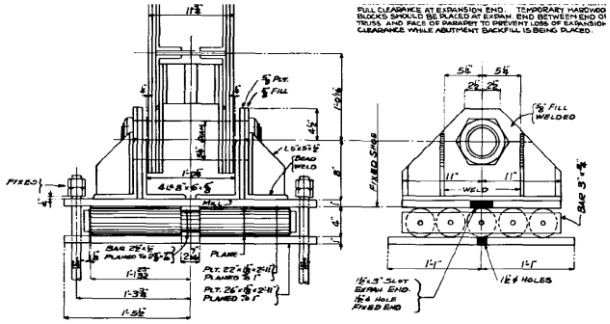
Sliding plate bearings often incorporate bronze plates or lubricants to facilitate movement.

Lateral restraint may be provided by guide tabs, or by anchor bolts extending up through slots in the sole plate.



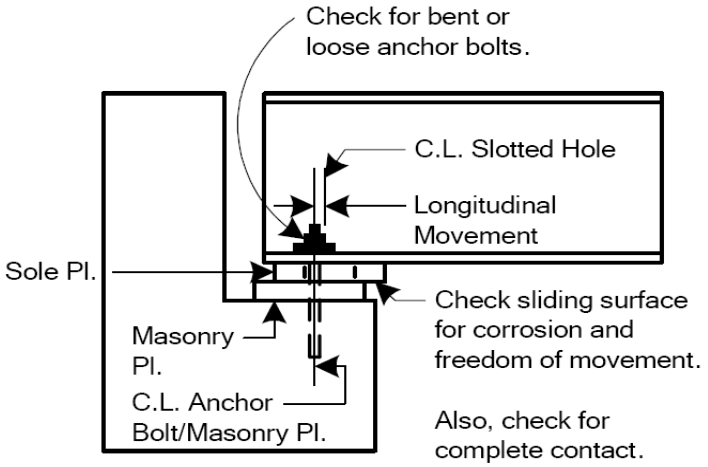
Rocker bearings are typically comprised of a curved rocker plate (bearing on the masonry plate), that is connected to the sole plate with an upper pin. The bearing may have a single rocker or multiple rockers ("rocker nest bearings").

Lateral restraint may be provided by pintles (attached to the masonry plate), pin caps, or anchor bolts extending up through slotted plates.

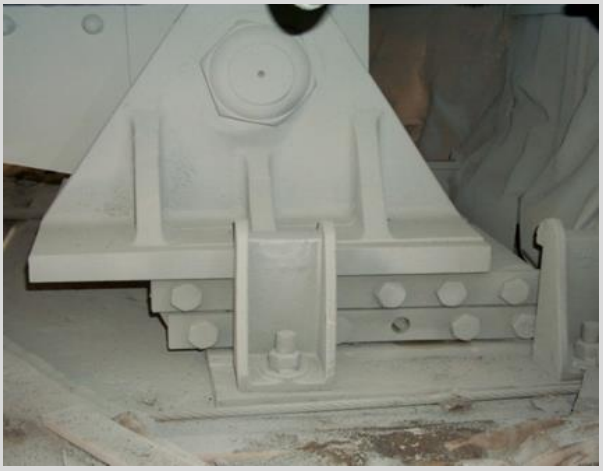


A roller bearing consists of a horizontal steel cylinder that "rolls" between the sole plate and masonry plate as the superstructure expands and contracts. The bearing may have a single roller or multiple rollers ("roller nest bearing").

Lateral restraint may be provided by pintles (on the top and bottom of the roller), or keeper bars attached the ends of the rollers.

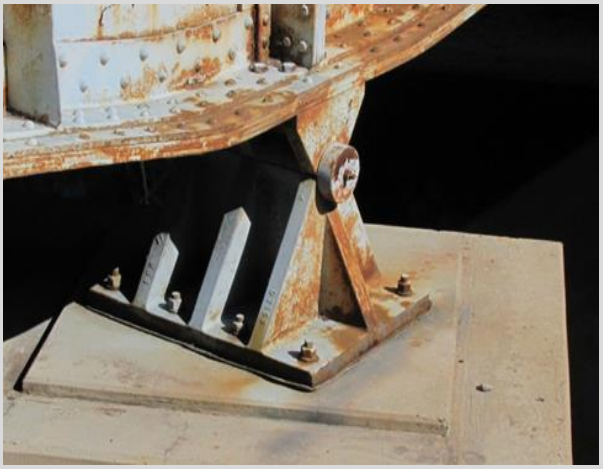


#311: Movable or Expansion Bearing (Each)				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Movement & Structural Review	No restriction of movement – bearing is functioning as intended.	Minor restriction (cleaning and/or lubrication recommended).	Restricted but not warranting structural review (no immediate structural concern). Cleaning and/or lubricating are required. Resetting or repairs recommended.	Severe restriction – structural review is warranted. **or** resetting, repairs, or bearing replacement are required.
Primary Bearing Components	Primary bearing components are intact and properly positioned.	Primary bearing components are moderately worn or slightly misaligned.	Primary bearing components are significantly worn, damaged, or misaligned.	Primary bearing components are severely misaligned, jammed or detached.
Corrosion (1000)	None.	Freckled rust (corrosion has initiated).	Section loss or pack rust is present.	Severe section loss impacts bearing function or capacity.
Connections (1020)	In place and functioning as intended.	Loose fasteners, but connection still functioning.	Missing fasteners (bolts, rivets, etc.) or broken welds.	Connection failure impacts bearing function or capacity.
Alignment (2220)	Alignment is appropriate for the current temperature.	Alignment is tolerable but is inconsistent for the current temperature	Alignment is near the design limits for expansion or contraction.	Alignment is beyond the design limits for expansion or contraction.
Lateral Guide System, Uplift Restraints, or Anchor Bolts	Guides, restraints, or anchor bolts (if present) are sound, properly positioned, and functioning properly.	Anchor bolt nuts loose or missing (bolts remain intact). Guide or restraint system has minor deterioration but is functioning properly.	Anchor bolts loose, bent or at expansion limits. Lateral guide system moderately worn or misaligned. Uplift restraint has moderate deterioration but is functioning properly.	Failure of anchor bolts or lateral guide system has severely impacted bearing function or capacity. Uplift restraint system has failed.
Loss of Bearing Area (2240)	None.	Less than 10%.	10% to 25%.	More than 25%.
Note: Bearings that are restrained from rotating due to bumpers or other methods are not a defect. The restraint system should be looked at to ensure that it is functioning as intended.				

#311: Expansion Bearing (Each)	
Condition Rating Examples (Expansion Bearings)	
 **Condition State 2** **Debris and surface corrosion on sliding plate bearing.**	 **Condition State 2** **Surface corrosion on a rocker expansion bearing.**
 **Condition State 3** **Sliding plate bearing near expansion limits (slide plate extends well beyond the masonry plate).**	 **Condition State 3** **Flaking rust and debris below rocker bearing (restriction of movement).**
 **Condition State 4** **Severe misalignment of rocker nest bearing due to substructure movement.**	 **Condition State 4** **Rocker bearing locked and sliding on the masonry plate.**

3.10.4 Fixed Bearing (Element #313)

#313: Fixed Bearing (Each)				
This element applies to bearings that are fixed against longitudinal movement of the superstructure. Fixed bearings may incorporate a pin, curved steel plate, or thin elastomeric pad to allow rotational movement (from live load deflection of the superstructure). Fixed bearings are typically designed to resist transverse movement and may be designed to resist uplift forces. The bearing nuts are designed to be approximately ¼" to ½" above the masonry or sole plate, depending on design, to allow for some rotational movement. Any larger gaps should be investigated.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review & Rotational Movement (If Allowed by Design)	Bearing is functioning as intended.	Minor rotational restriction (cleaning and/or lubrication recommended).	Rotational restriction not warranting structural review. Cleaning or lubricating required.	Severe rotational restriction. Structural review, repair, or replacement is required.
Primary Bearing Components	All components are intact and properly positioned.	Primary bearing components have moderate deterioration or slight misalignment.	Primary bearing components have significant deterioration or misalignment.	Primary bearing components have severe deterioration or misalignment (or have failed).
Elastomeric Pads or Lead Leveling Sheets	In place and functioning as intended.	Misaligned or extruded along the bearing plate.	Severely misaligned, deformed or extruded.	NA
Corrosion (1000)	None.	Freckled rust (corrosion has initiated).	Section loss or pack rust is present.	Section loss severely impacts bearing function or capacity.
Connections (1020)	In place and functioning as intended.	Loose fasteners, but connection still functioning as intended.	Missing fasteners (bolts, rivets, etc.) or broken welds.	Connection failure severely impacts bearing function or capacity.
Anchor Bolts, Anchor Rods and Uplift Restraints	Anchor bolts and uplift restraints (if present) are properly installed.	Anchor bolts slightly misaligned. Anchor rod projects ½" to 1" above bearing or bearing nut.	Anchor bolts loose or bent. Anchor rod projects 1" to 3" above bearing or bearing nut. Uplift restraint is still functioning.	Failure of anchor bolt (or uplift restraint). Anchor rod projects more than 3" above bearing or bearing nut.
Loss of Bearing Area (2240)	None	Less than 10%	10% to 25%	More than 25%
Note: Bearings that are restrained from uplift or other previously known issues are not a defect. The restraint system should be looked at to ensure that it is functioning as intended.				

#313: Fixed Bearing (Each)	
Condition Rating Examples (Fixed Bearings)	
 **Condition State 2** **Surface corrosion on a fixed pin bearing.**	 **Condition State 2** **Elastomeric pad is extruding and anchor bolt projects 4” above bearing.**
 **Condition State 3** **Improperly installed anchor bolt extends 8” above bearing.**	 **Condition State 3** **Flaking rust (section loss) and debris on two fixed pin bearings.**
 **Condition State 4** **Masonry plate cracked (and supporting pier fractured) on a fixed pin bearing.**	 **Condition State 4** **Anchor bolt failure on a fixed pin bearing (masonry plate has slid back to the parapet).**

3.10.5 Pot and Disk Bearings (Elements #314 and #315)

#314: Pot Bearing (Each)	#315: Disk Bearing (Each)
Pot and Disk bearings allow for multi-dimensional rotational movement. These are specialized bearings used for high loads (long spans, steel pier caps, or railroad bridges). It is difficult to distinguish pot bearings from disc bearings without referencing plans or shop drawings. • Pot bearings consist of a shallow steel piston resting within a steel cylinder, which contains a confined elastomer. Typically, only the perimeter edge of the elastomer is visible for inspection. Pot bearings are not recommended for use on railroad bridges. • Disk bearings consist of a shallow steel piston resting within a steel cylinder, which contains a semi-spherical disc (hard plastic or steel). The "disc" is enclosed within the assembly and is typically not visible for inspection.	
	Pot/Disk bearings may be "fixed" against horizontal movement (but allowing rotation), "guided expansion" (allowing horizontal expansion/contraction but lateral movement is restricted), or "non-guided expansion" (free to move in any direction). The photo on the left shows a fixed pot bearing with uplift restraint pins.
	On a typical expansion pot bearing, the upper plate has a "mirror finish stainless steel plate welded to the underside, and the lower plate has polytetrafluoroethylene (PFTE) bonded to the top surface. This combination provides an extremely low friction sliding surface (lubrication is not required). The photo on the left shows an expansion pot bearing with a center guide key. The stainless-steel plate should be examined for evidence of separation (or pack rust). Look for evidence of movement, such as wear near the guide or on the stainless-steel plate.
	On guided expansion pot bearings, look for evidence of wear, binding, or deterioration of the guide system. The upper piston plate should be properly seated (and positioned) within the lower cylinder plate. Visible portions of the elastomer should be examined for splitting, tearing, or extrusion. The photo on the left shows an expansion pot bearing with a guide bar on both edges. The lower plate should be examined for any wear or de-bonding of the PTFE. The presence of shavings in the photo at left indicates wear on the PTFE slide surface.
	The photo on the left shows an unguided expansion pot bearing. While these bearings are designed to allow free movement in any direction, any measurable lateral movement should be noted. Longitudinal movement can be measured by the offset between the centerline of the upper and lower plates.

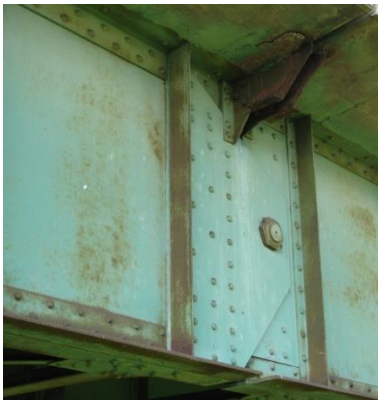
#314: Pot Bearing (Each) / #315: Disk Bearing (Each)				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Primary Bearing Components	Primary components are intact and properly positioned.	Primary bearing components are slightly worn or misaligned.	Primary bearing components are significantly worn or misaligned.	Primary bearing components are severely deteriorated, misaligned, jammed or detached.
Corrosion (1000)	None.	Freckled rust (corrosion has initiated).	Section loss or pack rust is present.	Section loss severely impacts bearing function or capacity.
Connections (1020)	In place and functioning as intended.	Loose fasteners, but connection still functioning as intended.	Missing fasteners (bolts, rivets, etc.) or broken welds.	Connection failure severely impacts bearing function or capacity.
Lateral Guide System, Uplift Restraints, or Anchor Bolts	Guides, restraints, or anchor bolts (if present) are sound, and functioning properly.	Anchor bolt nuts loose or missing (bolts remain intact). Guide or restraint system has minor deterioration but is still functioning properly.	Anchor bolts loose or bent. Lateral guide system moderately worn or misaligned. Uplift restraint system has moderate deterioration but is still functioning.	Failure of anchor bolts, lateral guide system, or uplift restraint system has severely impacted bearing function or capacity.
Movement and Structural Review (2210)	No restriction of movement – bearing is functioning as intended.	Minor restriction (cleaning and/or lubrication recommended).	Restricted but not warranting structural review (no immediate structural concern). Cleaning and/or lubricating required. Resetting or repairs recommended.	Severe restriction – structural review is warranted. **or** resetting, repairs, or bearing replacement are required.
Alignment (2220)	Alignment is appropriate for the current temperature	Alignment is tolerable but is inconsistent for the current temperature.	Alignment is near the design limits for expansion or contraction.	Alignment is beyond the design limits for expansion or contraction.
Bulging, Splitting or Tearing (2230)	None.	Bulging less than 15% of pad thickness. Minor rolling along pad edges.	Bulging more than 15% of pad thickness. Splitting or tearing (internal plates exposed). Significant rolling along pad edges. Pad surfaces are not parallel.	Splitting, bulging, de-bonding, or pad damage that severely impacts bearing function or capacity
Loss of Bearing Area (2240)	None.	Less than 10%	10% to 25%	More than 25%

#314: Pot Bearing (Each)	#315: Disk Bearing (Each)
Condition Rating Examples (Pot and Disk Bearings)	
 **Condition State 2** **Loose sole plate bolts on a fixed pot bearing.**	 **Condition State 2** **Teflon strop peeling off from the guide bar on a guided expansion pot bearing.**
 **Condition State 2** **Paint/galvanizing failure and surface corrosion on a fixed pot bearing.**	 **Condition State 3** **Pack rust on the sliding plate on a free expansion pot bearing.**
 **Condition State 3** **Teflon shavings due to wear on the sliding surface of a free expansion pot bearing.**	 **Condition State 3** **Flaking rust on a free expansion pot bearing.**

3.11 PIN AND HANGER ASSEMBLY/PINNED CONNECTION (ELEMENT #161)

This element applies to pin and hanger assemblies and fixed pin assemblies. This element should also be used for pin-connected trusses, arches, columns, or any pinned connection on a primary bridge structural element that is not rated under a bearing element.

Pin and Hanger Assembly on a Riveted Steel Girder Bridge



Fixed Pin Assembly on a Riveted Steel Girder Bridge

Ultrasonic Examination of a Pinned Truss Connection

On continuous steel bridges with cantilever or suspended spans (where the end of one span is supported by an adjacent span), the connection detail may consist of a pinned assembly. Pin and hanger (or fixed pin) assemblies are relatively rare in South Dakota. They are mostly present on steel multiple girder/beam bridges constructed from 1935 to 1975. A pin and hanger assembly typically consists of two vertical hanger plates with pinned connections at the top and bottom. This allows both rotation and longitudinal movement of the superstructure. Pin and hanger assemblies may incorporate a guide/restraint system to prevent lateral movement. A fixed pin assembly has only one pin. This allows rotation but restricts longitudinal movement of the superstructure.

Pinned assemblies on bridges that carry highway traffic require periodic ultrasonic examination. Pinned assemblies should be examined for deterioration, function, alignment, as well as the soundness of the adjacent superstructure support. All of these factors should be taken into consideration when rating a pinned assembly. All components of a pinned assembly (pins, plates, pin caps, nuts, washers, spacers, etc.) should be examined for wear, corrosion, defects, cracks, bending, loosening or misalignment. Note: Severe pack rust can deform hanger plates or result in failure of pinned connections.

Periodic measurements should be taken to verify the proper function of pin and hanger assemblies (be sure to record the temperature at the time of inspection). A frozen pin will transfer additional bending stresses to the hanger plates, any significant restriction of a pin and hanger assembly should be identified and analyzed immediately. Note: While the presence of fretting rust (a red-colored dust resulting from the wearing of steel surfaces) indicates that recent movement has occurred, it may also indicate inadequate lubrication.

#161: Pin and Hanger Assembly or Pinned Connection (Each)				
This element applies to steel pin and hanger assemblies or fixed pin connections. This element should also be used for pin-connected trusses, arches, columns, or any pinned connection on a primary bridge structural element that is not rated under a bearing element. • A pin and hanger assembly can be grouped as "1" when determining the element quantity. • As this is an NBE steel element, the coating system must be rated as a separate protective system/sub-element using Element #515, #815, #816, #817, or #818 (Steel Protective Coating).				
Item or Defect	**Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Movement and Structural Review	No restriction. Pinned connection is functioning as intended.	Minor restriction (cleaning and/or lubrication recommended).	Restricted but not warranting structural review. Cleaning or lubricating required. Repairs recommended.	Severe restriction – structural review is warranted. Repair or replacement is required.
Longitudinal Alignment (Pin & Hangers)	Alignment is appropriate for the current temperature.	Alignment is tolerable but is inconsistent for the current temperature.	Expansion or contraction is near the design limits.	Expansion or contraction is beyond the design limits.
Pinned Connection or Pinned Assembly Components	All components are intact and properly positioned.	Plates or pins have minor wear. Cotter pins missing.	Plates or pins are significantly worn. Cap nuts are loose.	Connection has failed (or failure is eminent). Pins or plates have severe wear. Cap nuts missing.
Corrosion (1000)	None.	Surface corrosion (freckled rust).	Section loss, flaking rust, or pack rust is present.	Section loss exceeds 10% of cross section.
Connection (1020)	Connection is in place and functioning as intended	Loose fasteners or minor surface rust is present, but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review. Repair or replacement is required.
Misalignment	None.	Slightly out of position or alignment.	Significantly out of proper position or alignment.	Severely out of proper position or alignment.
Distortion (1900)	None.	Mitigated distortion.	Significant distortion.	Severe distortion

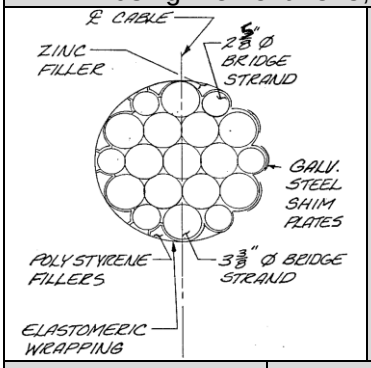
#161: Pin and Hanger Assembly or Pinned Connection	
Condition Rating Examples (Pinned Connections)	
 **Condition State 2** **Paint failure and surface corrosion on a pin and hanger assembly.**	 **Condition State 3** **Pin and hanger near limits of expansion, fretting rust on top pin and section loss on hanger plate.**
 **Condition State 3** **Pack rust distortion on the hanger plate on a pin and hanger connection.**	 **Condition State 4** **Severe pack rust and section loss on a pinned truss connection.**

3.12 STEEL CABLES (ELEMENTS #147 AND #148)

#147: Steel Main Cable (LF)

This element applies only to the primary steel support cables on suspension or cable-stayed bridges. The quantity is the total length of all main cables on the bridge, measured along the length of each main cable from anchorage to anchorage. Anchorages should be considered in the condition rating.

- Steel main cables are typically galvanized, and often have an additional protective wrapping and/or coating. The steel protective coating should be rated as a protective system/sub-element using Element #515, #815, #816, #817, or #818.



A cross-section of a main suspension cable is shown at the left. Each cable is comprised of 19 steel bridge strands. The bridge strands (3-3/8" or 2-5/8" diameter) are comprised of helically wound galvanized wires. Except inside the underground chambers (where the strands splay out to individual anchorages), only the outer elastomeric wrapping is visible for inspection (photo on right).

Item or Defect	Structural Element Condition States			
	1 Good	2 Fair	3 Poor	4 Severe
Structural Review	Structural review is not required.		Structural review is not required **or** structural review of existing defects has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** structural review has determined that the defects impact strength or serviceability.
Corrosion	None	Surface corrosion.	Section loss or pack rust.	Section loss exceeds 5% of the cross-section.
Frayed, Worn, or Damaged Cables	None	Minor wear or abrasion that has been mitigated. Minor strand or wire separation.	Active wear or abrasion at contact points. Isolated fraying or severing of individual wires. Significant strand or wire separation.	Severe wear or abrasion. Multiple wires frayed, severed or loose.
Cable Banding	Banding is intact.	Banding is loose.	Banding has failed.	NA
Vibration	Little or no vibration.	Slight (or mitigated) vibration.	Moderate vibration.	Significant vibration.
Cable Anchorage	Minor deterioration.	Moderate deterioration.	Significant deterioration. Evidence of slight cable loosening or slippage.	Severe deterioration or anchorage failure.

#148: Secondary Steel Cable (Each)				
This element applies to steel cables that transfer loads from the bridge superstructure to the main cable (or arch). Examples include vertical hanger cables on suspension or tied arch bridges. The quantity may be the total number of secondary cables or the number of secondary cable "groups" (groups of cables at one location). The cable anchorages should be included in the condition rating. Secondary cables are typically steel structural strands or wire ropes comprised of galvanized wires. • The steel protective coating should be rated as a sub-element using Element #515.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.		Structural review is not required **or** structural review of existing defects has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** structural review has determined that the defects impact strength or serviceability.
Corrosion	None	Surface corrosion.	Section loss or pack rust.	Section loss exceeds 5% of the cross-section.
Frayed, Worn, or Broken Strands	None	Minor wear or abrasion that has been mitigated. Minor strand or wire separation.	Active abrasion or wear at contact points. Isolated fraying of individual wires. Significant strand or wire separation.	Severe abrasion or wear. Multiple wires frayed, severed or loose.
Cable Banding	Banding is intact.	Banding is loose.	Banding has failed.	NA
Vibration	Little or no vibration.	Slight (or mitigated) vibration.	Moderate vibration.	Significant vibration.
Cable Anchorage	Minor deterioration	Moderate deterioration (no evidence of distress).	Significant deterioration. There may be evidence of loosening or slight slippage.	Severe deterioration or anchorage failure. There may be significant slippage.

#148: Secondary Steel Cable (Each)

Condition Rating Examples (Secondary Steel Cables)

Condition State 2
Minor wear on steel strand hanger cable.

Condition State 3
Active abrasion at contact point (steel wire rope hanger cable wearing against a steel batten plate).

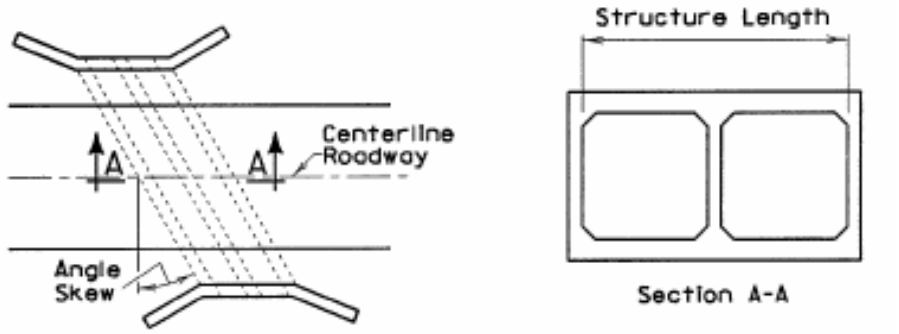
Condition State 3
Corrosion on steel strand hanger cable just above the anchorage socket.

Condition State 4
Cable failure due to fractured anchorage plate.

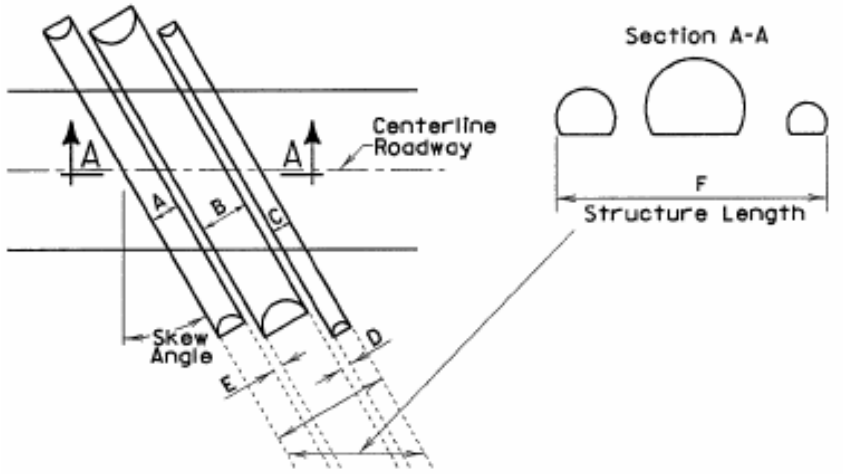
4. CULVERT ELEMENTS

4.1 INSPECTION PROCEDURES FOR CULVERTS

The FHWA requires inspection of any structure with a total length of 20 feet or greater as measured along center line of the road, regardless of the depth below grade. The measurement should be made between the inside faces of the exterior walls.



Multiple pipes may be considered a bridge if the distance between the pipes is less than half the smallest opening and the structure length is greater than or equal to 20 feet. In the illustration below, distance D and E must be less than half the distance C and distance F must be greater or equal than 20 feet for the pipes to be a bridge.



While culverts are typically designed to allow drainage below a roadway embankment, they may also serve as underpasses for vehicles, pedestrians, or livestock. Culverts are designed to support the dead load of the embankment material as well as live loads from traffic. If the embankment fill is more than 3 ft. deep, the fill is likely the primary load.

Culverts are constructed of a variety of materials, including concrete (cast-in-place or precast), corrugated steel plate, stone masonry, timber, or aluminum. The size and shape of a culvert is usually determined by the hydraulic requirements (the opening must be large enough to carry the design discharge). Culvert shapes include arch culverts, box culverts, round pipe culverts, pipe-arch culverts, or elliptical culverts. A culvert may consist of a single barrel or multiple barrels.

Culverts can be structurally classified as either “flexible” or “rigid”. Steel culverts are typically considered to be flexible – a flexible culvert derives a significant amount of structural strength from the surrounding soil (the lateral soil pressure helps to resist vertical loads). Concrete culverts are typically considered to be rigid – a rigid culvert provides its own structural strength and does not necessarily require embankment fill.

A complete culvert inspection should include examining the culvert barrels, end treatments, waterway, embankment slopes, and the roadway. Ideally, a walk-through inspection of the entire culvert barrel should be conducted during low water conditions (high water or ice can prevent inspection of critical areas). If an adequate walk-through inspection cannot be performed, it should be noted in the inspection report, and a complete inspection should be performed when conditions allow. If necessary, an underwater inspection may need to be performed.

During culvert inspection, two main items need to be determined - the hydraulic performance and the structural condition.

Hydraulic Performance: Poor hydraulic performance can result in excessive ponding, flooding of adjacent properties, or washouts of the embankment and roadway. The inspector should note any conditions that might reduce the hydraulic performance of the culvert. A reduction of the hydraulic performance that is not related to the structural condition of the culvert (such as sediment) would only impact the NBI channel rating.

- Poor horizontal or vertical channel alignment can reduce hydraulic efficiency, increase sedimentation, or accelerate embankment erosion. Culverts on flat grades may have excessive sediment, culverts on steep grades may have outlet scour.
- Accumulation of debris at the inlet (or excessive sedimentation within the barrel) can reduce the culvert's hydraulic capacity, accelerate embankment erosion, or alter the channel alignment. While some sedimentation is inevitable, any excessive sedimentation should be noted.
- Changes in land use such as wetland drainage, deforestation, or increased development can significantly increase the runoff (and resultant discharge) that a culvert must carry. Channel changes upstream (or immediately downstream) of the culvert can result in overtopping of the roadway. The inspector should note the high-water elevation (or freeboard), as well as any evidence of overtopping.
- All culverts in South Dakota should have the water level measured at every routine bridge inspection and recorded in the bridge inspection report from an established reference point. An example reference point could be the distance from the top of the parapet at a specific corner to the top of the water.

Structural Condition: Although culverts generally deteriorate at a slower rate than bridges, poor structural condition can eventually result in load restrictions or failure. The inspector should note any evidence of structural deterioration or distress. This includes material deterioration, barrel shape, and joint misalignment/separation. Photographs are useful for comparison to previous (or future) inspections.

Material Deterioration: The inspector should inspect all visible surfaces of the culvert and note both the extent and severity of any significant material deterioration.

- Concrete culverts should be examined for scaling, cracking, leaching, rust stains, delamination's, or spalls. Severe cracking may indicate uneven settlement or structural overloading (from traffic or excessive earth pressure). Any significant spalling (with exposed reinforcing steel) should be documented. Connection bolts on pre-cast concrete culverts should be examined for corrosion.
- Steel culverts should be examined for corrosion (particularly along the waterline). Bolted seams should be examined for cusping, loose, or missing bolts, and cracking around bolt holes.
- Timber culverts should be examined for weathering, splitting, warping, decay, fire damage, insect damage, or loose connections. Defects or connections can provide openings for moisture (and eventually decay) – any evidence of decay (such as fruiting bodies, staining, or surface depressions) should be noted.
- Masonry culverts should be examined for weathering, scaling, cracks, spalls, crushing, or misalignment of the masonry blocks. The mortar joints should be examined for any deterioration.
- Aluminum culverts are relatively resistant to corrosion but will corrode rapidly in highly alkaline environments.

Barrel Shape: As flexible culverts (steel, aluminum, or timber) rely upon the surrounding soil to provide lateral support, embankment stability is essential. Deflection or distortion of the barrel may indicate instability of the supporting soil and may reduce the load-carrying capacity of the culvert. Significant changes in the barrel shape should be noted (and verified with field measurements).

- Deflection is caused by long-term settlement over the length of the culvert (from embankment pressure). As the center of the embankment will settle more than the side slopes, culverts often end up with a low spot below the center of the roadway (steel culverts are often designed with a camber to compensate for this).
- Distortion is any deviation from the design cross-section of the culvert barrel, which should be symmetrical, with even curvature. Barrel distortion may be caused by uneven settlement, overloading, or from damage during the initial backfilling. Distortion is more common on culverts with less than 3 ft. of embankment fill.

Joint Misalignment and Separation: Joint misalignment or separation may be caused by improper installation, undermining, uneven settlement, or embankment failure. Leaking joints (exfiltration or infiltration) can eventually result in severe undermining or even culvert failure.

- ***Exfiltration*** is water leaking out of the culvert barrel – this can lead to "piping" (water flowing along the outside of the culvert barrel), which can eventually erode the supporting soil. The inspector should look for separated or mis-aligned joints and observe the culvert ends for evidence of piping.
- ***Infiltration*** is water leaking into the culvert – this can also erode the supporting soil. Infiltration can be difficult to detect, as the backfill deposits are often washed away. The inspector should look for staining at the joints on the sides and top of the culvert, or depressions above the culvert.
- Probing of the joint separation or misalignment should be considered to determine the size and depth of the void.

Like bridges, culverts must be rated using both the NBI and structural element condition ratings.

4.2 SNBI CONDITION AND APPRAISAL RATINGS

The overall structural condition of a culvert will be rated using the Culvert Rating (B.C.04). The deck, superstructure, and substructure condition ratings should all be listed as "N".

If the culvert is designed to carry water (even if the culvert barrel is normally dry) the channel should be rated using Channel Condition and Channel Protection Condition Rating (B.C.09 and B.C.10). This rating should reflect the channel alignment, as well as the presence of any sedimentation or debris. Overtopping likelihood is rated primarily on the frequency of overtopping of the roadway during high water events (B.AP.02).

Structural Element Condition Ratings: SDDOT uses the following elements specifically for culvert structures.

- **#240 – Steel Culvert (LF)**
- **#241 – Concrete Culvert (LF)**
- **#242 – Timber Culvert (LF)**
- **#243 – Other Material Culvert (LF) – Use for Aluminum or Plastic Culverts**
- **#244 – Masonry Culvert (LF)**
- **#245 – Prestressed Concrete Culvert (LF)**
- **#841 – Precast Concrete Culvert (LF)**
- **#842 – Culvert Wingwall (Each)**
- **#843 – Culvert Apron (Each)**
- **#871 – Roadway Over Culvert (Each)**

The condition of the culvert barrel must be rated using one of the above elements (depending upon the material type). The quantity is expressed in linear feet, as measured along the length of the barrel (multiplied by the number of barrels). If the condition varies along the length of the culvert barrel, more than one condition state may be used.

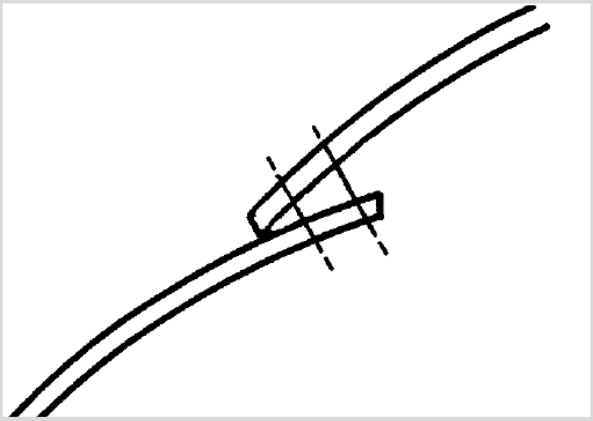
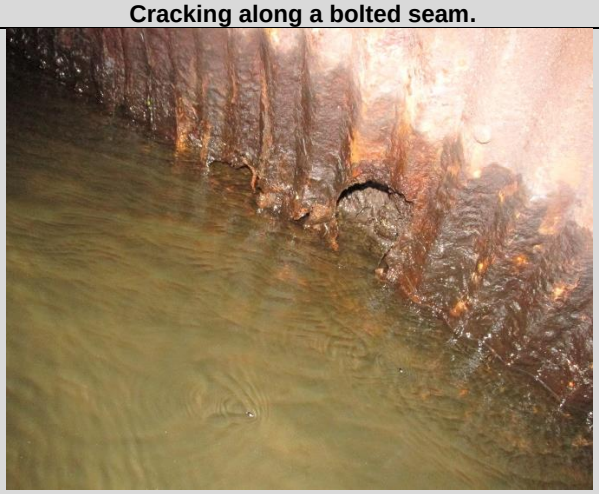
- If an arch culvert has concrete footings that are visible for inspection, they may be rated separately from the arch barrel using Element #220 (Reinforced Concrete Footing).
- SDDOT added Elements #842 and #843 to rate the condition of the culvert wingwalls and aprons. The inspector should note any corrosion, section loss, cracking, rotation, spalling, delamination's, or other types of general deterioration and chose the worst condition state following the DOT's defect priority rankings and the material type condition states.
    - Multiple pipe that are structure length, should only use Element #843, as the end treatment is typically one precast or cast-in-place unit. Each apron should be treated as a quantity of "1" for each end of the pipe. The below example would have a total quantity of six for the structure.

- SDDOT added Element #871 to rate the condition of the roadway above the culvert. The inspector should note any settlement or cracking of the roadway, as this may indicate culvert distortion (or voiding of backfill). On flexible (steel) culverts; look for settlement above the center line of the culvert. On rigid (concrete) culverts, look for settlement along the edges of the culvert.

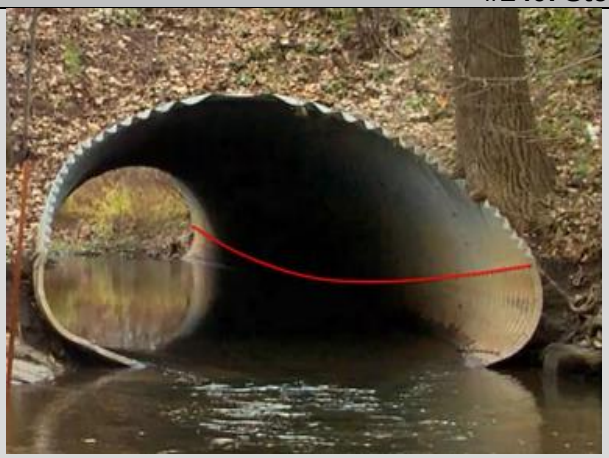
4.2.1 Steel Culvert (Element #240)

#240: Steel Culvert (LF)	
This element applies to steel culverts of any type or shape. Typically, there are four types of steel culverts – pipe-arch, round pipe, arch, or long span/elliptical. The LF quantity is measured along the length of the culvert barrel.	
	**Steel Pipe-Arch Culverts** A common steel culvert shape. The low-profile design requires less fill than a round pipe and provides a wider channel during low flow.
	**Steel Round Pipe Culverts** A common steel culvert shape.
	**Steel Arch Culverts** Spans typically range from 10 ft. to 24 ft. Footings are typically reinforced concrete. Some steel arch culverts have masonry headwalls.
	**Steel "Long Span" or Elliptical Culverts** This category includes elliptical culverts, as well as various culverts shapes with spans longer than 20 ft. (such low-profile arch, high profile arch, underpass, or pear shape). The most common shape is elliptical. Span lengths typically range from 20 ft. to 33 ft.

#240: Steel Culvert (LF)				
As with all other steel elements, the protective coating (typically galvanized or bituminous) should be rated using Elements #515, #815, #816, #817, or #818 Steel Protective Coating.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review or Repairs	No structural repairs are present.	Structural review or repairs are not required. Existing structural repairs are in sound condition.	Repairs may be recommended (structural review is not required) **or** structural review has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** structural review has determined that the defects impact strength or serviceability.
Corrosion (1000)	None.	Surface corrosion.	Flaking rust or section loss.	Severe section loss (holes or significant loss of thickness).
Cracking (1010)	None.	Crack has been arrested or reinforced.	Crack has not been arrested, reinforced, or mitigated.	Severe crack or fracture.
Connection - Bolted Seams (1020)	Bolted seams are tight and functioning as intended.	Bolted seams have minor openings or distress.	Bolted seams or joints have significant distress (cusped or cocked) or significant openings. Bolts may be tipped, loose, or missing.	Bolted seams have failed or buckled.
Joint Separation or Backfill Infiltration	None.	Minor joint separation backfill infiltration.	Moderate joint separation or backfill infiltration.	Severe joint separation or backfill infiltration.
Barrel Distortion (1900)	None.	Slight distortion (less than 5% change from design dimensions). Barrel shape remains mostly symmetrical.	Significant distortion (5% to 10% change from design dimensions). Barrel may have notable asymmetry.	Severe distortion – more than 10% change from design dimensions. Severe buckling of corrugations.
Settlement - Longitudinal Deflection (4000)	None or within design limits.	Slight longitudinal deflection (within tolerable limits). No structural distress.	Significant longitudinal deflection (exceeds tolerable limits).	Severe deflection – stability or function of culvert has been reduced.
Scour (6000)	None	Within tolerable limits (or countermeasures installed).	Exceeds tolerable limits but less than critical scour limits.	Exceeds the critical scour limits.

#240: Steel Culvert (LF)	
Condition Rating Examples (Steel Culverts)	
 **Condition State 2** **Surface corrosion along the waterline.**	 **Condition State 3** **Flaking rust along the water line.**
 **Condition State 3** **Cracking along a bolted seam.**	 **Condition State 4** **Diagram showing a "cusped" bolted seam**
 **Condition State 3** **Through corrosion along the water line.**	 **Condition State 4** **Failed seam along the bottom of a culvert.**

#240: Steel Culvert (LF)

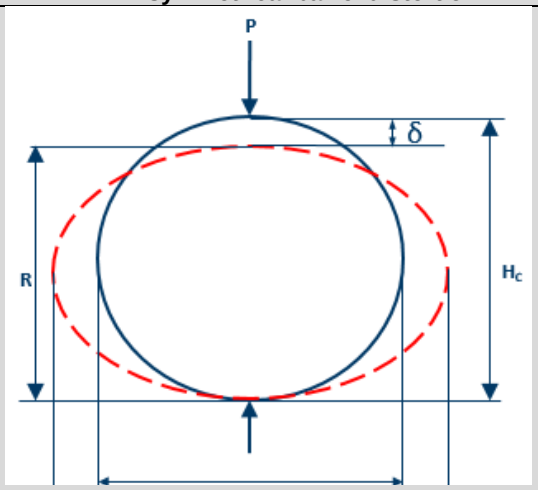


Condition State 3
Significant longitudinal deflection.

Condition State 4
Severe buckling of corrugations in sidewall.

Condition State 3
Asymmetrical barrel distortion.

Condition State 4
Severe barrel distortion.



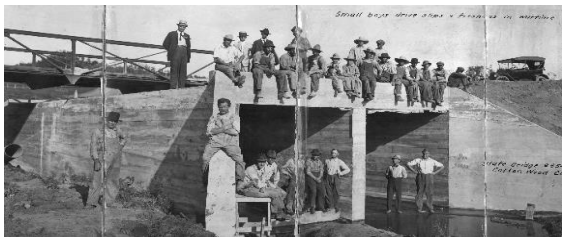
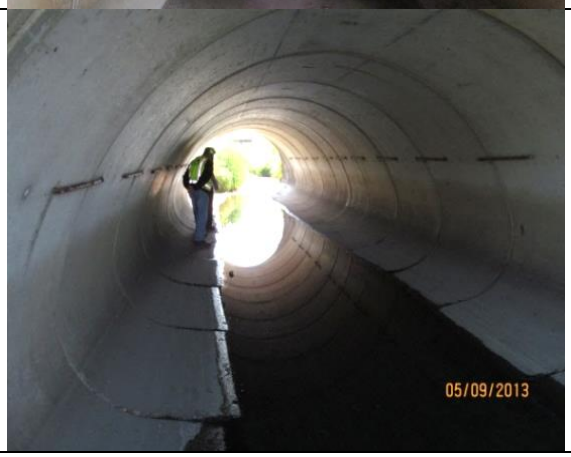
Hc =Culvert height specified in original design
R = measured rise
δ = Hc-R (vertical culvert deflection at crown)

Deflection ratio = δ/Hc

Note, if the deflection ratio is higher than 10%, the culvert may need to be closed, repaired, or replaced.

Symmetrical Culvert Barrel Distortion Measurement Diagram

4.2.2 Concrete Culvert (Elements #241, #245, and #841)

#241: Reinforced Concrete Culvert (LF) #245: Prestressed Concrete Culvert (LF)	#841: Precast Concrete Culvert (LF)
This element applies to concrete culverts of any type or shape. There are five common concrete culvert shapes (box, pipe-arch, round pipe, arch, or rigid frame/3-sided), and two common construction methods, precast and cast-in-place concrete culverts. The LF quantity is measured along the length of the culvert barrel.	
 	**Cast-in-Place (CIP) Concrete Box Culverts** CIP box culverts are extensively used in South Dakota from the early 1900's to today. Typical spans range from 4 ft. up to 20 ft.
 	**Precast Concrete Box Culverts** A fairly common culvert type in South Dakota, they were introduced in the 1970s. Typical SDDOT standard dimensions for span lengths range from 6 ft. to 16 ft. and barrel heights from 4 ft. to 12 ft. Precast box culvert sections are typically 6 ft. long, but 4 or 5 ft. sections are also common. The precast sections are connected with steel tie bolts.
	**Precast Concrete Pipe-Arch (RCPA) Culverts** Introduced in the 1950's. The standard dimensions for spans ranging from 51" up to 169" (14 ft. - 1 in.). The precast sections are typically 6 ft. long and connected with steel tie rods. Smaller RCPA culverts have a one-piece end treatment. Larger spans have a three-section end treatment.

#241: Reinforced Concrete Culvert (LF) #245: Prestressed Concrete Culvert (LF)	#841: Precast Concrete Culvert (LF)
	**Precast Concrete Round Pipe (RCP) Culverts** Precast concrete round pipe (RCP) culverts came into use in the 1920's – these are the oldest precast concrete structures in South Dakota. While RCP culverts are still commonly used in South Dakota, most of them are too small to meet the legal bridge definition. The standard pipe diameters range from 2 ft. to 11 ft. (the segments are typically 6 ft. long).
	**Precast Concrete Arch Culverts** Precast concrete arch culverts were introduced in the 1980s and 1990s. The footings are typically cast-in-place, while the headwalls and wingwalls are typically precast. There are common spans ranging from 24 ft. to 44 ft. (the precast sections are 6-8 ft. wide). A variety of shapes and larger span lengths are also available from several manufacturers.
	**Cast-in-Place Concrete Arch Culverts** Cast-in-place concrete arch culverts require extensive formwork and are generally no longer being constructed in South Dakota. Typical spans range from 10 ft. to 30 ft.
 	**Concrete Rigid Frame (3-Sided) Culverts** 3-sided culverts are supported by footings (and/or pilings) and have a natural streambed. They may be pre-cast or cast-in-place. They may have a flat or arched top. These are a relatively new structure type. Flat-top shapes are generally limited to spans up to 30 ft. Arch top designs are available in spans up to 48 ft.

#241: Reinforced Concrete Culvert (LF) #245: Prestressed Concrete Culvert (LF)	#841: Precast Concrete Culvert (LF)			
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review or Repairs	No structural repairs are present.	Structural review or repairs are not required. Existing structural repairs are in sound condition.	Repairs may be recommended (structural review is not required) **or** structural review has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** structural review has determined that the defects impact strength or serviceability.
Delamination, Spall, or Patched Area (1080)	None.	Delamination. Spall 1" or less deep **and** 6" or less in diameter. Existing repair in sound condition.	Spall more than 1" deep **or** more than 6" diameter. Repairs are recommended **or** existing repair is unsound or distressed.	Spalling greater than 3" deep. Full-depth failures present or imminent. Immediate repairs are required.
Exposed Reinforcement (1090)	None.	Exposed rebar without measurable section loss.	Exposed rebar with measurable section loss.	Exposed rebar has severe section loss.
Cracking (PC) and Pattern/Map Cracking (1110)	Insignificant cracks (less than 0.004") or moderate width cracks that have been sealed.	Unsealed moderate (0.004" to 0.009") width cracks or unsealed moderate density pattern/map (spacing of 1-3' on center) cracking.	Wide (0.009" to 0.02") cracks. Heavy density pattern/map (spacing of 1' or less on center) cracking.	Severe (greater than 0.02") cracks or full depth fractures.
Efflorescence, Water/Salt Saturation, Rust Staining or Leaching (1120)	None	Light leaching (little or no build-up) or light water saturation.	Heavy leaching (significant build-up or stalactites). Significant water/salt saturation. Rust stains indicating rebar corrosion.	Severe leaching or severe salt/water saturation. Concrete is unsound.
Cracking and Pattern/Map Cracking (1130)	Insignificant cracks (less than 0.012") or moderate width cracks that have been sealed.	Unsealed moderate (0.012" to 0.05") width cracks. Unsealed moderate pattern/map (spacing of greater than 1' to 3' on center) with moderate width cracking.	Wide (greater than 0.05" to 0.125") cracks. Heavy pattern/map with unsealed moderate width cracking or greater (spacing of 1' or less on center).	Severe (greater than 0.125") cracks or full depth fractures. Failure may be plausible
Scale, Abrasion, or Wear (1190)	Superficial.	Coarse aggregate is exposed (½" deep or less) but remains secure in the concrete matrix.	Coarse aggregate is loose (greater than ½" to 3") or popped out of the concrete matrix.	Severe voiding (greater than 3") or concrete is unsound.

#241: Reinforced Concrete Culvert (LF) #245: Prestressed Concrete Culvert (LF)	#841: Precast Concrete Culvert (LF)			
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Settlement (4000)	None.	Exists within tolerable limits (less than 2” at greatest extent) or has been arrested with no observed structural distress.	Exceeds tolerable limits (2” up to 4”).	Exceeds critical limits (greater than 4”).
Scour (6000)	None.	Within tolerable limits or countermeasures installed.	Exceeds tolerable limits but less than critical scour limits.	Exceeds the critical scour limits.
Connections	Connections are in-place and functioning as intended.	Connection rods have minor distress. Bolts of connectors misaligned – nuts loose or missing.	Connection rods have significant distress (bolts or connectors have significant section loss).	Connection rods have failed or are missing.
Joint Misalignment, Leakage, or Backfill Infiltration	None.	Minor joint separation, leakage, offset, misalignment or backfill infiltration.	Moderate joint separation, leakage, offset, misalignment or backfill infiltration.	Severe joint separation, leakage, offset, misalignment or backfill infiltration.

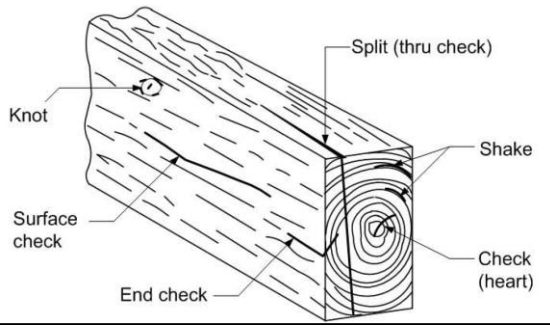
- Cracks are typically documented as a linear feet (LF) quantity and are assumed to be 1’ wide for ease of calculations and consistency.
- As a general rule, pattern or map cracked areas or areas with concentrated cracking should be documented and are rated as a LF area – use engineering judgement.
- Settlement is to be applied for the whole section length from Joint X to Joint Y. Other defects (equal or higher in rating) are to be rated first, and settlement takes over the remainder.

#241: Reinforced Concrete Culvert (LF) #245: Prestressed Concrete Culvert (LF)	#841: Precast Concrete Culvert (LF)
Condition Rating Examples (Concrete Culverts)	
 **Condition State 2** **Minor joint separation/backfill infiltration in-between the segments of a precast box culvert.**	 **Condition State 2** **Leaching cracks on a cast-in-place (CIP) concrete box culvert.**
 **Condition State 3** **Heavy leaching on a cast-in-place (CIP) concrete box culvert.**	 **Condition State 3** **Spalling (exposed rebar) on a cast-in-place (CIP) concrete box culvert.**
 **Condition State 3** **Severe separation and deterioration at a construction joint on a cast-in-place (CIP) concrete box culvert.**	 **Condition State 4** **Severe spalling on a precast concrete elliptical culvert.**

4.2.3 Timber Culvert (Element #242)

#242: Timber Culvert (LF)				
This element applies to timber box culverts. The LF quantity is measured along the length of the culvert barrel (and multiplied by the number of barrels).				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review or Repairs	No structural repairs are present.	Structural review or repairs are not required. Existing repairs are in sound condition.	Repairs recommended (structural review not required) **or** structural review has determined that strength/serviceability hasn't been impacted.	Condition warrants structural review **or** structural review has determined that the defects impact strength or serviceability.
Connection (1020)	In-place and functioning as intended.	Loose fasteners but functioning as intended.	Missing fasteners; broken welds; or pack rust.	Connection has failed (or failure is eminent).
Decay, Abrasion, or Fire Damage (1140)	Minor deterioration (no section loss).	Less than 10% section loss. No crushing or sagging.	10% to 40% section loss. Some crushing or sagging.	More than 40% section loss. Severe crushing or sagging.
Shakes, Checks, or Splits (1160 or 1170)	Less than 5% of the member thickness.	5% to 50% of the member thickness (not in a tension zone).	More than 50% of member thickness (or more than 5% in a tension zone).	Through entire member (or more than 25% in a tension zone).
Joint Misalignment, Leakage, or Backfill Infiltration	None.	Minor joint separation, leakage, offset, misalignment or backfill infiltration.	Moderate joint separation, leakage, offset, misalignment or backfill infiltration.	Severe joint separation, leakage, offset, misalignment or backfill infiltration.
Settlement or Longitudinal Deflection (4000)	None	Slight deflection (within tolerable limits). No structural distress.	Significant longitudinal deflection (exceeds tolerable limits).	Severe deflection. Stability or function of culvert has been reduced.
Scour (6000)	None	Within tolerable limits or countermeasures installed.	Exceeds tolerable limits but less than critical scour limits.	Exceeds the critical scour limits.

- **Shake:** A separation along the grain (between the growth rings). Usually forms within a standing tree or during felling.
- **Check:** A separation perpendicular to the grain (across the growth rings). Usually results from stress due to drying shrinkage.
- **Split (or Thru Check):** A check extending further through the timber member due to tearing apart of wood cells.



#242: Timber Culvert (LF)

Condition Rating Examples (Timber Culverts)

Condition State 2
Separation between timber members on a timber box culvert (no backfill infiltration).

Condition State 2
Evidence of decay along the water line of a timber box culvert.

Condition State 3
Wall section misaligned on a timber box culvert.

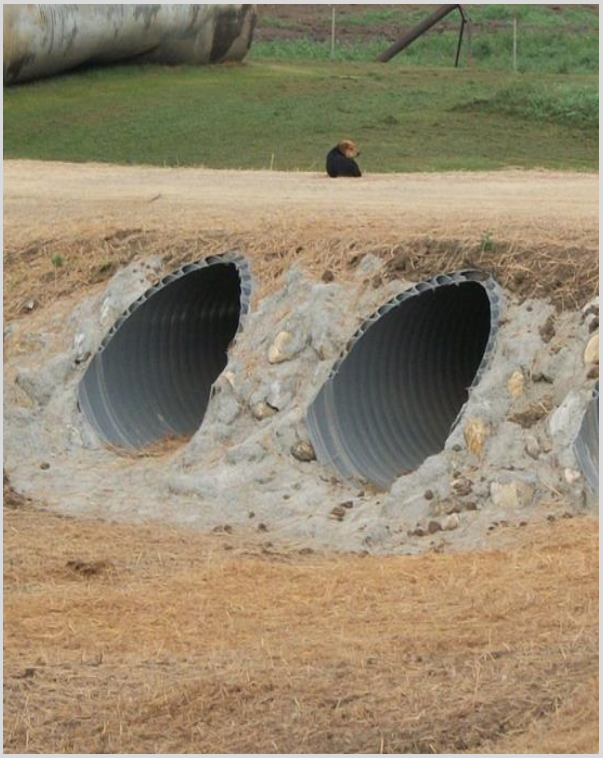
Condition State 4
Separation (connection failure) between wall and ceiling on a timber box culvert.

4.2.4 Other Material Culvert (Element #243)

#243: Other Material Culvert (LF)				
This element applies to culverts constructed of materials other than steel, concrete, timber, or masonry. Examples include aluminum box culverts or plastic culverts. The LF quantity is measured along the length of the culvert barrel.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** Structural review has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** Structural review has determined that the defects impact strength or serviceability.
Repairs (1080)	No repairs are present.	Existing repair in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Other Deterioration	None	Initiated breakdown or deterioration.	Significant deterioration.	Severe or critical deterioration.
Corrosion (1000)	None	Surface corrosion.	Section loss.	Severe section loss (holes).
Cracking (1010 or 1130)	None	Crack has been arrested or mitigated.	Crack has not been arrested or mitigated.	Crack has reduced the strength or stability.
Connection – Bolted Seams (1020)	Connections functioning as intended.	Minor seam distress – some bolts may be loose.	Significant seam distress – bolts may be missing.	Seams have failed.
Barrel Distortion (1900)	None	Slight distortion (less than 5% change from design dimensions).	Significant distortion (5% to 15% change from design dimensions).	Severe distortion – more than 15% change from design dimensions.
Settlement – Longitudinal Deflection (4000)	None	Slight deflection. Within tolerable limits or arrested (no distress).	Significant deflection. Exceeds tolerable limits.	Severe deflection. Stability or function has been reduced.
Joint Misalignment, Leakage, or Backfill Infiltration	None.	Minor joint separation, leakage, offset, misalignment or backfill infiltration.	Moderate joint separation, leakage, offset, misalignment or backfill infiltration.	Severe joint separation, leakage, offset, misalignment or backfill infiltration.
Scour (6000)	None	Within tolerable limits (or countermeasures installed).	Exceeds tolerable limits but less than critical scour limits.	Exceeds critical scour limits.

#243: Other Material Culvert (LF)

Condition Rating Examples (Other Material Culverts)



Condition State 1
Plastic pipe culvert (DWPE – Double Wall Polyethylene).

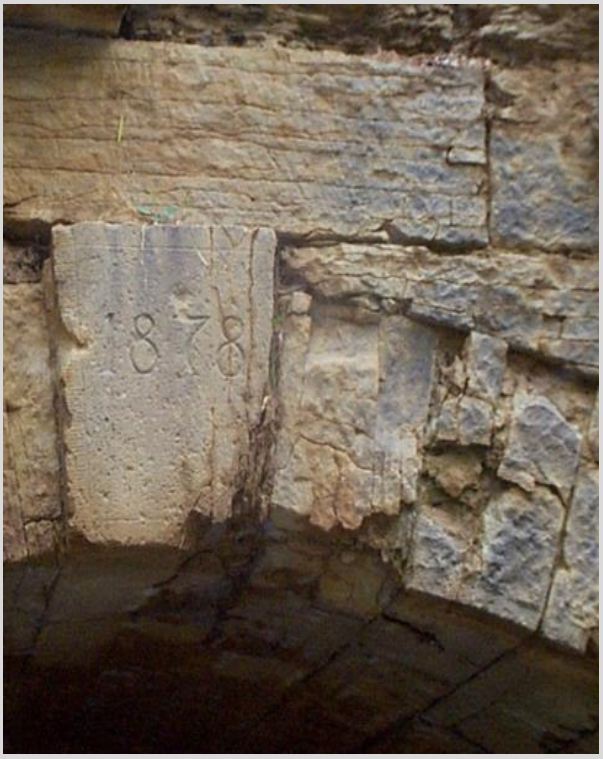
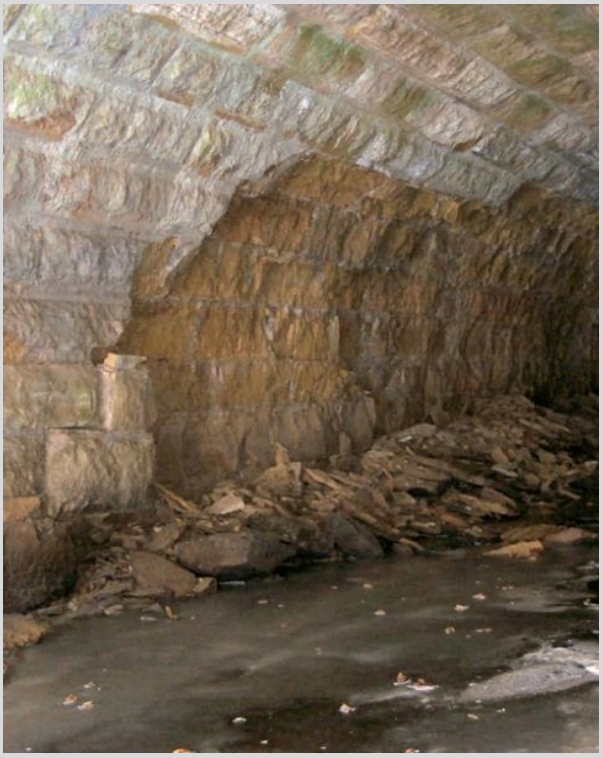
Condition State 1
Aluminum Box Culvert.

Condition State 3
Torn edge on an aluminum box culvert.

Condition State 4
Failed seam on an aluminum box culvert.

4.2.5 Masonry Culvert (Element #244)

#244: Masonry Culvert (LF)				
This element applies to arch culverts with arch barrels comprised primarily of masonry. Spans typically range from 10 ft. to 22 ft. The LF quantity is measured along the length of the culvert barrel.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	Structural review is not required **or** structural review has determined that strength or serviceability has not been impacted.	Condition warrants structural review **or** structural review has determined that the defects impact strength or serviceability.
Repairs (1630)	No repairs are present.	Existing repair in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Mortar Breakdown (1610)	None	Cracking or voids in less than 10% of the joints.	Cracking or voids in 10% or more of the joints.	NA
Delamination or Spall (1080)	None	Delamination. Spalling less than 10% loss of block thickness.	Spalling with 10% to 25% loss of block thickness.	Spalling with more than 25% loss of block thickness.
Spilt or Fracture (1620)	None	Block split without continuation into adjacent courses.	Fractured through adjacent courses or block split with significant offset.	Fracture or split reduces stability of structure.
Weathering, Scale or Abrasion	Minor surface deterioration (no section loss).	Less than 10% loss of block thickness.	10% to 25% loss of block thickness.	More than 25% loss of block thickness.
Masonry Displacement (1640)	None	Block or stone is slightly misaligned.	Block or stone is significantly misaligned.	Block or stone is severely misaligned (or detached from structure).
Settlement (4000)	None	Within tolerable limits or arrested.	Exceeds tolerable limits.	Stability of element has been reduced.
Joint Misalignment, Leakage, or Backfill Infiltration	None.	Minor joint separation, leakage, offset, misalignment or backfill infiltration.	Moderate joint separation, leakage, offset, misalignment or backfill infiltration.	Severe joint separation, leakage, offset, misalignment or backfill infiltration.
Scour (6000)	None	Within tolerable limits (or countermeasures installed).	Exceeds tolerable limits but less than critical scour limits.	Exceeds critical scour limits.

#244: Masonry Culvert (LF)	
Condition Rating Examples (Masonry Culverts)	
 **Condition State 2** **Weathering (section loss less than 10%) of fascia blocks on a masonry arch culvert.**	 **Condition State 3** **Scour (mortar missing) along the water line on a masonry arch culvert.**
 **Condition State 4** **Severe (and extensive) spalling on a masonry arch culvert.**	 **Condition State 4** **Severe vertical fracture (with blocks misaligned and loose) on a masonry arch culvert.**

4.2.6 Roadway over Culvert (Element #871)

#871: Roadway over Culvert (1 Each)

This element rates the condition of the roadway running above a culvert structure. It must be rated for all culvert structures that carry vehicular traffic. This includes paved or unpaved (gravel) roadways.

- The type of wearing surface and number of traffic lanes should be noted. If possible, the year of pavement installation (or overlay) should also be noted.
- If the roadway is divided with a median, then a quantity of 2 may be used.

Cracking or settlement of the roadway may be the result of culvert settlement, barrel distortion, or voiding of backfill. On flexible (steel) culverts; look for cracking and settlement above the center line of the culvert. On rigid (concrete) culverts, look for cracking and settlement along the edges of the culvert.

Item or Defect	Structural Element Condition States			
	1 Good	2 Fair	3 Poor	4 Severe
Roadway Condition (General)	Little or no deterioration. No patches.	Minor to moderate deterioration. Permanent patches that remain sound.	Extensive deterioration (repairs recommended). Temporary patches or deteriorated repairs.	Severe deterioration (possible safety hazard – immediate repairs required). Repair patches that have failed.
Concrete Paving	Minor cracking (no significant spalling).	Moderate cracking. Minor spalling.	Significant cracking or spalling.	Severe/extensive cracking or spalling.
Bituminous Paving	Smooth and even (minor cracking – no potholes).	Moderate cracking or slight rutting (some potholes present).	Significant cracking, rutting, or uneven surface. Extensive potholes.	Severe rutting, fractures, or potholes.
Gravel Roadway	Evenly graded.	Moderately rutted or eroded.	Extensive rutting or erosion.	Severe rutting or washouts.
Roadway Settlement or Undermining	None.	Slight settlement or minor undermining.	Significant settlement or undermining.	Severe settlement or undermining.

#871: Roadway over Culvert (1 Each)

Condition Rating Examples (Roadway over Culvert)

Condition State 1
Minor cracking in a bituminous roadway above a masonry arch culvert.

Condition State 2
Bituminous patches (due to settlement) along both sides of a concrete box culvert.

Condition State 3
Temporary patch due to settlement (loss of backfill above a severely corroded steel culvert).

Condition State 3
Temporary patch due to settlement (loss of backfill above a severely corroded steel culvert).

Condition State 4
Severe settlement of a bituminous roadway above a collapsed steel culvert.

Condition State 4
Roadway closed due to culvert failure.

4.2.7 Culvert End Treatments (Elements #842 and #843)

#842: Culvert Wingwall (Each) #843: Culvert Apron (Each)				
These elements apply to culvert end treatments of any type or material. This is an ″each″ item. • On single barrel culverts, the quantity will typically be four (two wingwalls for each end) for element 842 and two (one apron for each end) for element 843. • For multiple barrel culverts with a center wingwall extension(s), the extension should also be counted for element 842. • If no end treatments are present, these elements should not be used.				
Item or Defect	**Structural Element Condition States**			
	1	**2**	**3**	**4**
	Good	**Fair**	**Poor**	**Severe**
Structural Review	Structural review is not required.	Structural review is not required.	A structural review is not required, **or** a structural review has determined that capacity or function has not been impacted.	Condition warrants a structural review **or** structural review has determined that the capacity has been reduced.
Repairs	No repairs are present.	Existing repair in sound condition.	Repairs are recommended **or** existing repair is unsound.	Immediate repairs are required.
Steel	Minor surface corrosion.	Moderate surface corrosion (minor section loss).	Extensive corrosion (measurable section loss).	Advanced corrosion (severe section loss).
Concrete	Superficial scaling.	Moderate scaling (minor spalling).	Significant spalling or extensive scaling.	Severe spalling or scale.
	Minor cracking.	Moderate cracking or light leaching.	Extensive cracking or moderate leaching.	Severe cracking or deterioration.
Timber	Minor splitting.	Moderate splitting or decay.	Extensive splitting or significant decay.	Severe splitting or advanced decay.
Masonry	Minor weathering or mortar deterioration.	Moderate weathering, scaling, spalling, or mortar deterioration.	Extensive scaling, spalling, cracking, or mortar deterioration.	Severe scaling, cracking, or spalling.
Aluminum or Plastic	Superficial deterioration.	Moderate deterioration.	Significant deterioration.	Severe deterioration.
Connections	In-place and functioning as intended.	Connections are loose or missing (major components are secure).	Some connections have failed (major components may be loose).	Connection failure has significantly reduced structural integrity.
Joint Misalignment or Backfill Infiltration	None.	Minor joint separation, misalignment, or back fill infiltration.	Moderate joint separation, misalignment, or backfill infiltration.	Severe joint separation, misalignment, or backfill infiltration.
Settlement or Scour	None.	Within tolerable limits or arrested.	Exceeds tolerable limits.	Stability of element has been reduced.

#842: Culvert Wingwalls (Each)
#843: Culvert Aprons (Each)

Condition State 2
Repair of a wingwall to parapet connection.

Condition State 2
Moderate cracking and light leaching along the front face of the wingwall.

Condition State 2
Damage to the top of a bin wall/wingwall.

Condition State 3
Extensive crack at the wingwall to barrel connection.

Condition State 3
Extensive cracking/significant spalling at the wingwall to parapet connection.

Condition State 3
Scour exceeds tolerable limits at the end of the apron.

#842: Culvert Wingwalls (Each)
#843: Culvert Aprons (Each)

Condition State 4
Severe spalling and deterioration along the top of the wingwall.

Condition State 3/4
Extensive to severe cracking and deterioration of the cutoff wall to apron connection.

Condition State 4
Severe cracking, spalling, and deterioration of the wingwall.

Condition State 4
Failure of the apron and the cutoff wall.

4.2.8 Other Elements

The elements in this section are intended to track bridge (or culvert) components not addressed by the AASHTO NBE or BME elements. These elements are “Each” items. These are SDDOT elements and are not reported to the FHWA. The intent was a place to make any notes related to this element or that they even exist at a bridge.

- #880: Utilities – The quantity should equal one if present.

5. INSPECTION DOCUMENTATION

Inspection Notes

Inspection notes are a key component of a bridge inspection report. The inspection notes should provide a clear narrative of the condition of the bridge and must appropriately justify the SNBI and structure element condition ratings. Thorough inspection notes will allow the Engineer/Program Administrator reviewing the report to better understand the current condition of the bridge and determine if repairs or further structural analysis are required. If the bridge condition is accurately described, it is much easier to identify any change in condition in subsequent inspections. The quality of bridge inspection notes will generally reflect the quality of the bridge inspection, and the quality of the agency's bridge inspection program. Bridge inspection reports are legal, public documents – inspectors should keep that in mind when taking field notes and entering them in BrM.

Notes should be taken and entered in BrM for each bridge inspection. The extent of notes taken during an inspection will vary depending upon the size and the complexity of the bridge, the condition of the bridge, and the change in condition since the last inspection. When creating a new inspection in BrM, notes may be entered in several locations.

SNBI Component Condition Rating Notes: When a new bridge is entered into the database, the SNBI Component Condition Ratings will initially be entered as ″9″ or ″N″.

- SNBI ratings must not be rated as "9" after the initial field inspection.
- The inspector should enter a note whenever an SNBI Condition Rating is changed (up or down).
- As the SNBI condition ratings describe the general overall condition of a structure, the notes do not need to be specific or lengthy. At a minimum, these notes should briefly describe when and why the current condition rating was assigned. For example: ″SNBI deck condition rating lowered from 6 to 5 in 2024 due to delamination and spalling on underside of deck″.
- Notes are mandatory if a SNBI component condition rating is ″5″ (fair condition) or lower.

SNBI Bridge Appraisal Rating and Roadside Hardware Notes: Notes may be entered in BrM.

- If the coding for SNBI items B.AP.01 (Approach Roadway Alignment) or B.AP.02 (Overtopping Likelihood) is revised, the notes should explain why this was done.
- The notes for SNBI items B.RH.01 (Bridge Railings) and B.RH.02 (Transitions) should briefly describe why the current coding was selected.

Structure Element Notes: Every structure element has a dedicated section in BrM for entering inspection notes. It is recommended that the structure element notes include a brief description of the structure element being rated - this is particularly helpful on large or complex bridges.

- Inspection notes are mandatory for any structure element rated lower than condition state 1.
- The structure element notes should clearly describe the extent, severity, and location of any defects present on that element.
- When entering an inspection in BrM, notes are carried over from previous inspections. Thus, it is recommended that inspection notes are dated or completely overwritten with new notes from the current inspection. Dated inspection notes allow the reviewer to determine changes in condition, and to identify when structural modifications were performed (or when dead loads were added to the structure).
- While the exact manner of dating inspection notes will vary, it is recommended that the year the condition was observed precede the inspection note. Example, "[2012] South fascia girder has 10 LF of surface corrosion on the exterior bottom flange, extending out from the west abutment".
- When the condition changes during a subsequent inspection, the year the condition was first observed, as well as the year the condition last changed, should precede the inspection note. Example, "[2012/2014] South fascia girder has 15 LF of surface corrosion on the exterior bottom flange, extending out from the west abutment."
- Old structure element notes that are covered by a thin overlay (epoxy chip seal, etc.) should be kept in the event the thin overlay fails and the defect becomes visible again. The notes should contain the caveat they are from a condition prior to the overlay.
- Old structure element notes that no longer apply to the bridge should be deleted.
    - Examples:
        - If a deck expansion joint is replaced, notes describing the previous expansion joint should be deleted.

General Inspection Notes: Notes that do not apply to a specific structure element (or SNBI item) may be placed in a "General Notes", "Agency Inspection Notes" or "Region Repair Recommendations/Contract Repairs" area.

- On larger multi-span structures, the general layout of the bridge from the original construction plans should be described. Example, "Bridge runs from the south to the north, with piers and spans numbered from the south."
- It is also helpful to describe the beam numbering system used on the bridge framing plan. Example, "Beams are numbered 1-6 starting from the west."
- If a structure has had significant structural modifications (such as bridge widening, bridge re-decking, or a culvert extension), a brief note should describe the modifications and when they were performed.
- If high water (or snow), prevents a full inspection, it should be noted here so that a follow-up inspection can be performed.
- If a bridge carries railroad traffic (or crosses over a railroad), emergency contact information for the railroad should be provided. If possible, the railroad mile point should be noted to assist in identifying the structure to the railroad.

Inspection Photographs

A digital camera is basic bridge inspection equipment. Photographs should be taken (and entered in BrM) during each routine bridge inspection. Photos can provide an excellent illustration of changes in the condition of a bridge (or culvert) over time. Note: Photographs should not be used as a replacement for inspection notes, but rather to complement the inspection notes.

Section 2.2.1 of the AASHTO Manual for Bridge Evaluation requires that these three general photographs must be included in the file for each bridge. Taking these three photographs during each routine inspection will ensure that each bridge file will have up-to-date photographs to meet this requirement.

1. Top view of the roadway across the bridge (or culvert)
2. A side elevation view of the bridge (or culvert)
3. An underside view of the main span (or a typical span)

1. Roadway across Bridge

2. Side Elevation View

3. Underside View

Section 2.2.1 of the AASHTO Manual for Bridge Evaluation also states that these additional photos should be included in the bridge file.

- Critical findings **must** always be documented with photographs.
- If a primary structural element is rated as condition state 4, at least one photograph of the element is required during each routine inspection.
- Load posting restrictions (if present)
- Other important features

Other strongly recommended photographs to take during a routine bridge inspection (or have in the bridge file) include the following.

- Significant damage or deterioration (primary elements rated as condition state 3).
- Serious safety hazards.
- General and/or close-up view of primary structural elements (even if there is little or no deterioration) to provide a baseline of the general structural condition.
- Structural repairs or modifications.
- Height restriction signing (if present).
- Significant or unusual bridge features.
- Upstream and downstream views of the channel or waterway below the bridge.
- Deck or approach expansion joint gaps.
- Bearing orientation.
- Safety features (railings and guardrail).
- Utilities or other ancillary items that have been added to the bridge.

Measuring & Documenting Section Loss on Steel Members

Corrosion is the most common defect found on steel bridges. Any measurable loss of the original steel member cross-section due to corrosion is referred to as "section loss". Accurately measuring and documenting the extent and location of section loss is one of the primary responsibilities of the bridge inspector and is essential in evaluating the load-carrying capacity of a steel bridge.

The bridge inspection report should accurately describe the location and extent of any significant section loss. Section loss is typically expressed as a percentage of the original cross-sectional area.

- On members subjected to axial loading (such as truss members), section loss is typically expressed as percentage of the entire member cross-section. *Example: "Truss bottom chord member L2-L3 has 15% section loss at the L2 connection."*

- On members subjected to bending moment (such as girders or beams), section loss is typically expressed as percentage of the bottom flange, top flange, or the web cross-section. *Example: "The bottom flange of the west girder has 10% section loss at the 1st deck drain east of Pier #2."*

When describing section loss in an inspection report, it is important that the extent of section loss not be misrepresented. For example, the bottom flange of a steel beam has a 1" diameter hole rusted through, which constitutes 15% of the total bottom flange cross-section at that location. This should not be described as "*the bottom flange has 100% section loss*", but rather as "*the bottom flange has 15% section loss*" (or "*the bottom flange has a 1" diameter hole*").

If the original cross-section has not yet been determined, it may be better to describe the location and dimensions of the area with section loss. *For example: "Girder #3 has 4" wide by 2" high area of pitting (up to 1/8" deep) at the west abutment bearing".*

When should section loss measurements be performed? As a general rule, section loss measurements should be taken if the approximate section loss on a primary structural steel member exceeds 5% of the total member cross-section (or 5% of the flange or web cross-section). As it is not generally practical to accurately measure and document every area of section loss on a bridge, some judgment must be used by the inspector in prioritizing the locations where section loss measurements are taken. Highly stressed portions of the structure (such as the bottom flange near the center of a span) should be prioritized for section loss measurements. If section loss is present at similar details throughout a bridge, measurements should be taken at locations that appear to have the most severe and/or extensive section loss.

Locations where section loss is likely on bridges: The locations where corrosion (and section loss) will occur on a bridge are typically predictable – steel members exposed to salt spray or covered by debris will typically have section loss. The exact locations will vary depending upon the structural configuration and features present on the bridge – locations where corrosion (and section loss) is likely to occur include the following.

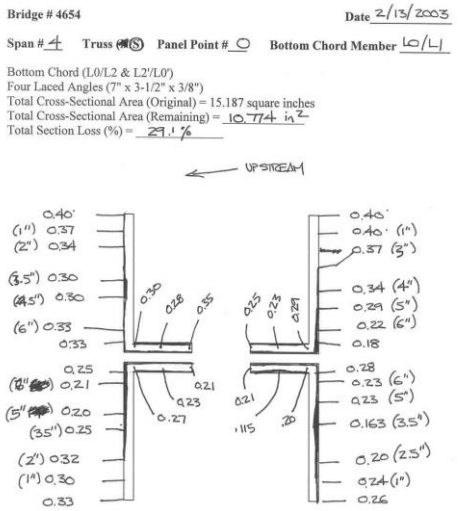
- Structural members located below deck joints.
- Bearing areas.
- Areas below deck drains or adjacent to downspouts.
- Areas located directly above traffic (exposed to salt spray).
- Horizontal surfaces, field splices, or other details that tend to accumulate debris.
- Fascia girders, beams, or stringers will typically have more corrosion and section loss than interior members – particularly along the exterior bottom flange.
- On bridges with concrete decks, corrosion will tend to be localized (below deck joints or leaching cracks) – on bridges with timber decks, corrosion may be widespread.

- Through truss and pony truss bridges will typically have section loss along the bottom chord, particularly at the panel point connections – section loss may be present on the truss members or gusset plates. Truss diagonal and vertical members will typically have corrosion at the railing connections, at the curb level, and at the bottom chord connections.
- Steel box girders (or other box sections) will develop internal corrosion if moisture accumulates within the box section.
- Steel piling will typically have corrosion at the water line and/or ground line.

Cleaning prior to inspection: In order to properly inspect a steel member (and to determine the extent of section loss) – the steel must first be cleaned of any dirt, debris, or excess flaking rust. A large build-up of debris on a steel member indicates not only inadequate maintenance, but also indicates inadequate inspection. A bridge inspector should have ready access to cleaning tools such as a shovel, spade, whisk broom, wire brush, pick hammer, or scraper. Inspection during (or immediately after) re-painting contracts will often allow for more precise section loss measurements.

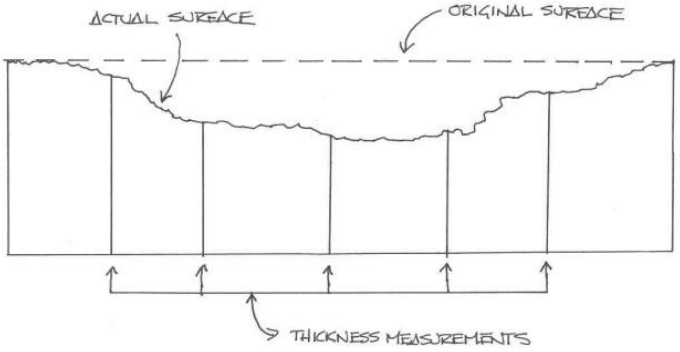
Methods of measurement: During a bridge inspection, initial section loss is often estimated (often aided by a straight edge or ruler) – as section loss advances, more precise measurements may be necessary. Calipers are a simple and inexpensive method of measuring the thickness of the remaining steel, but they may not be able to reach some locations (such as a girder web). An ultrasonic thickness gauge is the most precise and effective method of obtaining thickness measurements – this can be used in confined areas or locations where only one side of the member is accessible.

Field notes and cross-section diagrams: Field notes should be thorough, concise, and readable – they should include not only the thickness measurements, but the exact location where those measurements were taken. To determine the extent of section loss on a structural member, the original cross section area must be known. If no plans are available, measurements and thickness readings should be taken in areas without section loss to establish a basis for the section loss calculations. Plan dimensions and thicknesses should be verified. Cross-section diagrams are helpful in documenting field measurements and performing section loss calculations. If possible, blank forms (with cross section diagrams) should be prepared prior to taking field measurements. To facilitate section loss calculations, the exact location of all thickness readings should be recorded – areas with section loss should be clearly indicated.

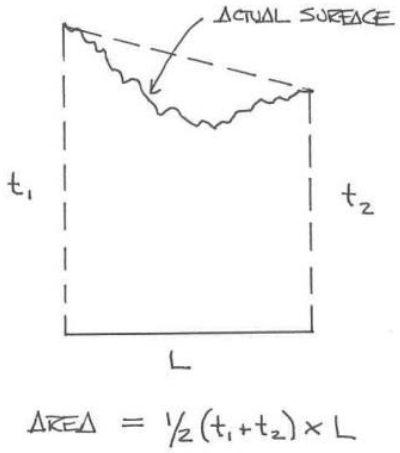


Example of cross section diagram with section loss field measurements

Section loss calculations: When performing section loss calculations, the level of accuracy will generally depend on how many thickness measurements are taken – the more measurements are taken, the greater the accuracy. One common method of calculating section loss is to simply take the average of several thickness measurements over a portion of the member cross-section. A slightly more accurate method is to divide the cross-section into trapezoidal sub-areas, based upon the exact locations of the thickness measurements – these areas are then calculated separately and added up. Whatever method is used, it should be done clearly and consistently, so the calculations can be easily checked and verified.



Cross-section showing location of thickness measurements



Trapezoidal sub-area

6. BRIDGE STRUCTURE TYPES AND COMPONENTS

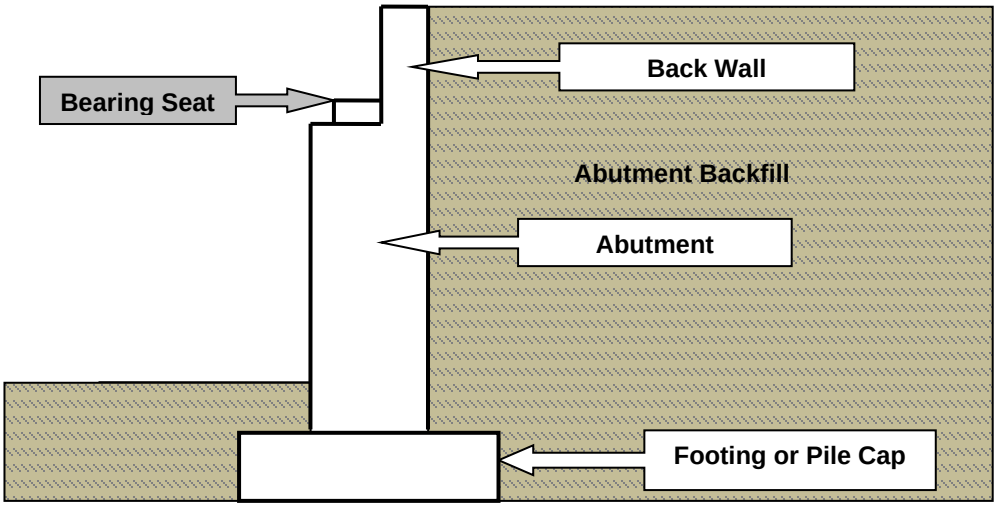
Note: This section is incomplete – it will eventually include general inspection procedures and condition rating guidelines for common bridge deck, superstructure, and substructure types. This is intended to be a condensed version of the guidelines in the Bridge Inspector's Reference Manual (BIRM).

7.1 SUBSTRUCTURE COMPONENTS

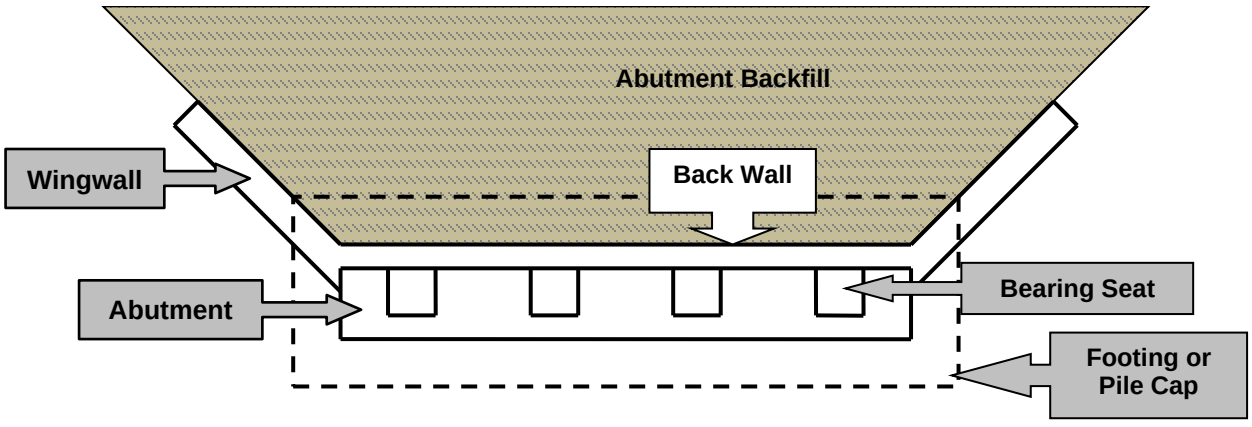
This section includes general inspection procedures and condition rating guidelines for substructure components (abutments and piers). This includes general descriptions and terminology, as well as guidelines for the proper selection of structural elements (and determining element quantities).

7.1.1 Concrete Abutments

Most abutments are constructed of reinforced concrete, while the overall configuration will vary, most concrete abutments share the following typical components.



Cross-section of a Typical Sill-Type Concrete Abutment



Plan View of a Typical Sill-Type Concrete Abutment

- **Abutment:** The abutment is the primary component of the abutment – it transmits the load of the bridge superstructure to the footing, and retains the abutment backfill. Only the front face is typically visible for inspection.
- **Bearing Seat:** The bearing seat provides a horizontal bearing area for the superstructure.
- **Backwall:** The back wall prevents backfill soil from sliding onto the bearing seat and provides support for the deck expansion joint (or approach slab).
- **Footing or Pile Cap:** The footing transmits the weight of the abutment, the soil loads, and the load of the bridge superstructure to the supporting soil. A footing may be supported by piling (pile cap) or may transfer these loads directly to the supporting soil or rock (spread footing).
- **Wingwall:** A wingwall is a short retaining wall extending from each end of the abutment that serves to retain the side slope. The wingwall configuration (height, length, and angle from the abutment face) will vary depending upon the abutment geometry and site conditions.

General inspection procedures for concrete abutments:

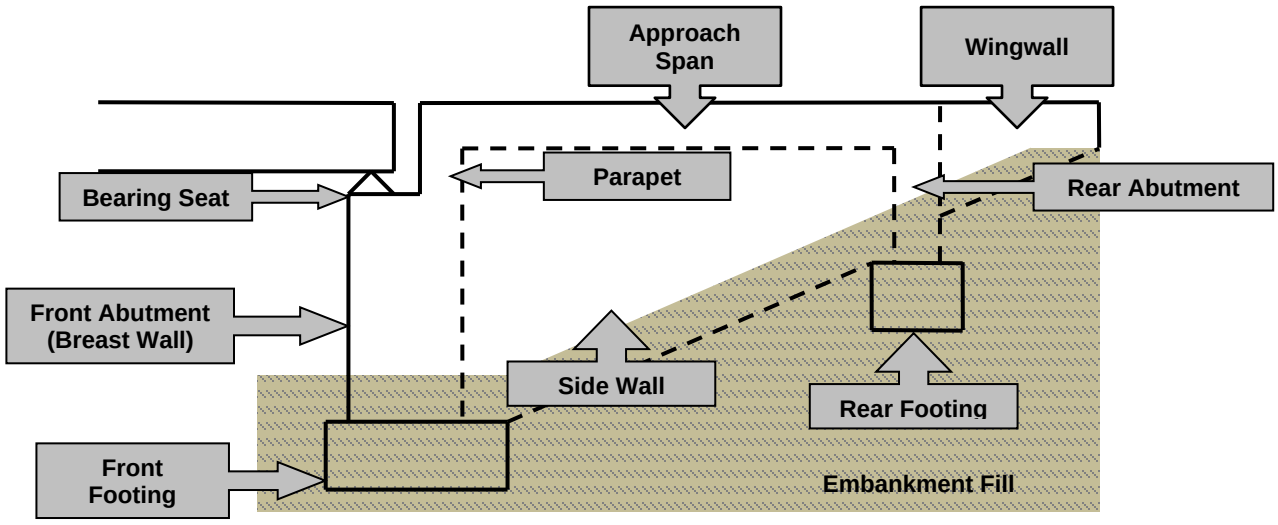
- Note any concrete deterioration (cracking, leaching, rust staining, delamination, or spalling).
- Note any evidence of deck joint leakage (such as staining on the abutment face or debris on the bearing seat).
- Weep holes (typically located near the base of the stem) should be examined for proper function.
- Note any distress on the backwall (cracking, spalling, or tipping) resulting from the superstructure contacting the backwall or from approach pavement thrust.
- Note any evidence of settlement, rotation, or other movement.
- Note any deterioration of the slope protection, slope erosion, undermining, or footing/piling exposure if not designed to be exposed.
- If the abutment is submerged in water, probe along the front face for any evidence of scour (review the underwater inspection report, if applicable).

Condition ratings for concrete abutments: An abutment has two basic functions – to support the bridge superstructure, and to retain the abutment backfill. The condition ratings should reflect not only the condition of the visible concrete surfaces, but also the ability of the abutment to perform these two basic functions.

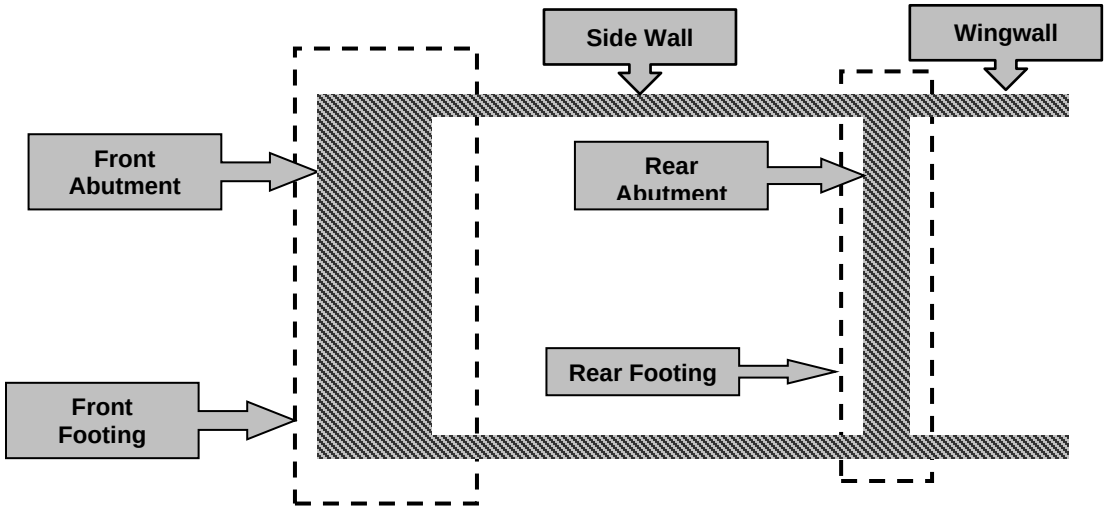
- Element #215 (Reinforced Concrete Abutment) should be used to rate the backwall, bearing seat, abutment, and integral wingwalls. This is a linear foot (LF) item – the quantity is determined by measuring horizontally across the front face of the abutment and along the length of any integral wingwalls.
- As the footings (and pilings) supporting a concrete abutment are typically not visible for inspection, they are typically not rated. If the abutment footing or piling are visible for inspection, it can be rated using the following:
    - Element #220 – Reinforced Concrete Pile Cap/Footing (LF)
    - Element #225 – Steel Piling (Each)
    - Element #226 – Prestressed Concrete Piling (Each)
    - Element #227 – Reinforced Concrete Piling (Each)
    - Element #228 – Timber Piling (Each)
- If settlement, rotation, or other movement of the abutment is evident, Defect #4000 (Settlement) should be used to note and quantify the defect.
- If scour is present, Defect #6000 (Scour) should be used to note and quantify the defect.

7.1.2 Hollow ("Vaulted") Concrete Abutments

Hollow or "Vaulted" reinforced concrete abutments are an enclosed approach span, typically a cast-in-place concrete slab or T-girder span. The side walls enclose the sides of the span, creating a "hollow" abutment that appears to be solid. Hollow abutments are intended to reduce the dead load (compared to a solid abutment) and subsequent settlement of the abutment. Note: Periodic internal inspections should be performed to assess the condition of the interior elements – confined space entry procedures are typically required.



Elevation View of a Hollow Concrete Abutment



Section View (Looking Down) of a Hollow Concrete Abutment

Element #215 (Reinforced Concrete Abutment) should be used to rate hollow "Vaulted" abutments. The LF quantity is measured around the exterior perimeter (front face and side walls, including any integral wingwall extensions). An element or elements must also be selected to rate the enclosed approach span – this may include beam, deck, or slab elements.

- **Front Abutment:** The front abutment (or breast wall) is the primary component of the abutment – it transmits the load of the bridge superstructure to the footing or pile cap, and retains the abutment backfill. Only the front face is typically visible for inspection.
- **Bearing Seat:** The bearing seat provides a horizontal bearing area for the superstructure.
- **Parapet:** The parapet (or back wall) provides support for the deck expansion joint and approach span.
- **Footing:** The footing transmits the weight of the abutment and the load of the bridge superstructure to the supporting soil. A footing may be supported by piling or may transfer these loads directly to the supporting soil or rock (spread footing).
- **Side Wall:** Encloses the sides of the span, creating a "hollow" abutment that appears to be solid.
- **Wingwall:** A wingwall is a short retaining wall extending from each end of the abutment that serves to retain the side slope. The wingwall configuration (height, length, and angle from the abutment face) will vary depending upon the abutment geometry and site conditions.

General inspection procedures for concrete vaulted abutments:

- Note any concrete deterioration (cracking, leaching, rust staining, delamination or spalling).
- Note any evidence of deck joint leakage (such as staining on the abutment face or debris on the bearing seat).
- Weep holes (typically located near the base of the stem) should be examined for proper function.
- Note any distress on the parapet (cracking, spalling or tipping) resulting from the superstructure contacting the parapet or from approach pavement thrust.
- Note any evidence of settlement, rotation, or other movement.
- Note any deterioration of the slope protection, slope erosion, undermining, or footing/piling exposure.
- If the abutment is submerged in water, probe along the front face for any evidence of scour (review the underwater inspection report, if applicable).

Condition ratings for concrete abutments: An abutment has two basic functions – to support for the bridge superstructure, and to retain the abutment backfill. The condition ratings should reflect not only the condition of the visible concrete surfaces, but also the ability of the abutment to perform these two basic functions.

- Element #215 (Reinforced Concrete Abutment) should be used to rate the abutment, bearing seat, parapet, side walls, and integral wingwalls. This is a linear foot (LF) item – the quantity is determined by measuring horizontally across the front face of the abutment and along the length of the side walls, and any integral wingwalls.
- As the footings (and pilings) supporting a concrete abutment are typically not visible for inspection, they are typically not rated. If the abutment footing is visible for inspection, it can be rated using Element #220 (Reinforced Concrete Pilecap/Footing). This is a LF item.
- If settlement, rotation, or other movement of the abutment is evident, Defect #4000 (Settlement) should be used to note and quantify defect.
- If scour is present, Defect #6000 (Scour) should be used to note and quantify defect.

7.1.3 Integral and Semi-Integral Concrete Abutments

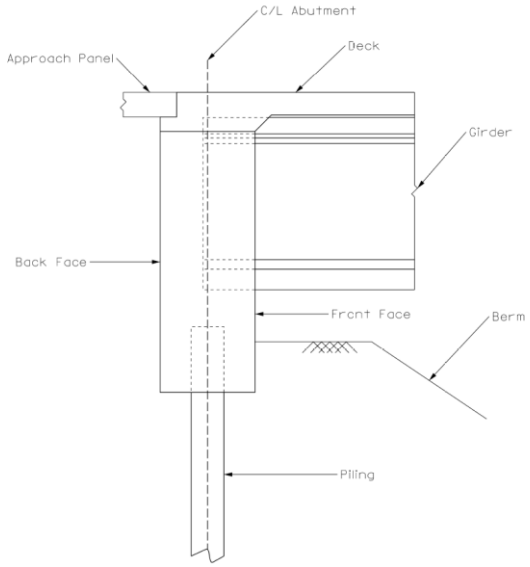
Integral and semi-integral abutments are now the preferred design for new bridges in South Dakota, as they eliminate the need for a deck expansion joint. Sill type abutments are now only used when the design criteria for integral or semi-integral abutments cannot be met.

An integral abutment consists of a concrete abutment stem supported by a single line of piles. The beams, girders, or slabs bear upon the abutment stem. Concrete, poured with or after the deck is poured, encases the beam ends, making the superstructure, deck, and often the approach panel integral with the abutment.

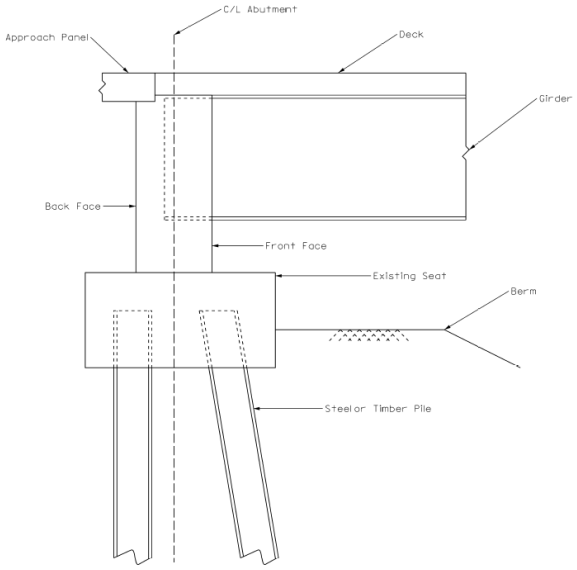
A semi-integral abutment is like an integral abutment in that the superstructure, deck, and approach panel are integral and expand and contract as a single unit. The primary difference is that the superstructure is supported on the abutment wall, allowing the superstructure to move independently from the abutment seat. Another difference is that the stem footing is typically supported by multiple rows of piles.

Use the criteria below when rating the condition of an integral or semi-integral abutment.

- The abutment stem should be rated using Element #215 (Concrete Abutment) and should be considered a part of the substructure.
- Bearing elements will typically be used only if bearing assemblies are present on the abutment stem and are visible for inspection.
- If integral concrete approach panels are present, Elements #320 (Precast Concrete Approach Slab) or #321 (Concrete Approach Slab) will typically be used.



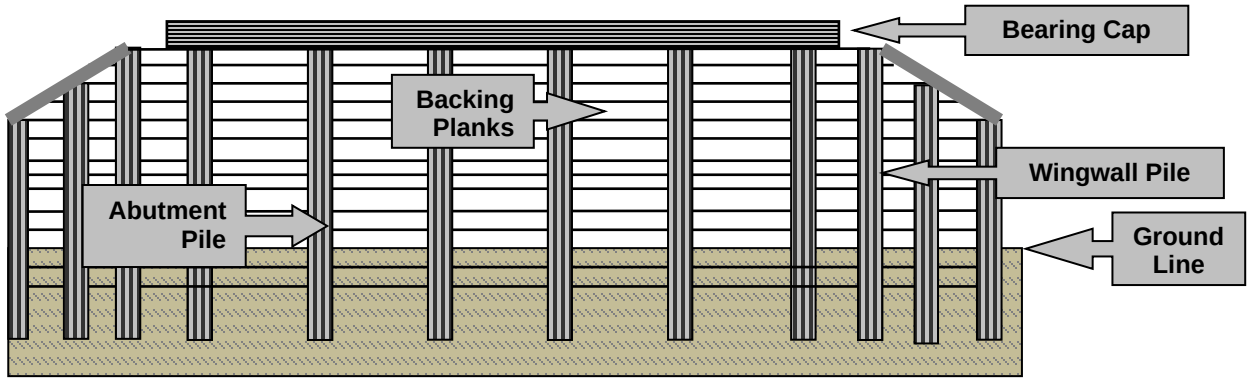
Integral Abutment (Cross Section)



Semi-Integral Abutment (Cross Section)

7.1.4 Timber Abutments

Timber abutments are typically comprised of three main components (backing planks, bearing cap, and piling), which are rated using three separate structural elements. These components may be connected with bolts, straps, lag screws, nails, spikes, or drift pins. The inspector should determine the condition of each timber element, as well as the overall orientation and stability of the abutment. The presence of failed connections or misaligned members should be reflected in the element ratings. Note: If the abutment has tipped, rotated, or settled, Element #883 (Substructure Settlement and Movement) must be rated accordingly.



Front View of a Typical Timber Abutment

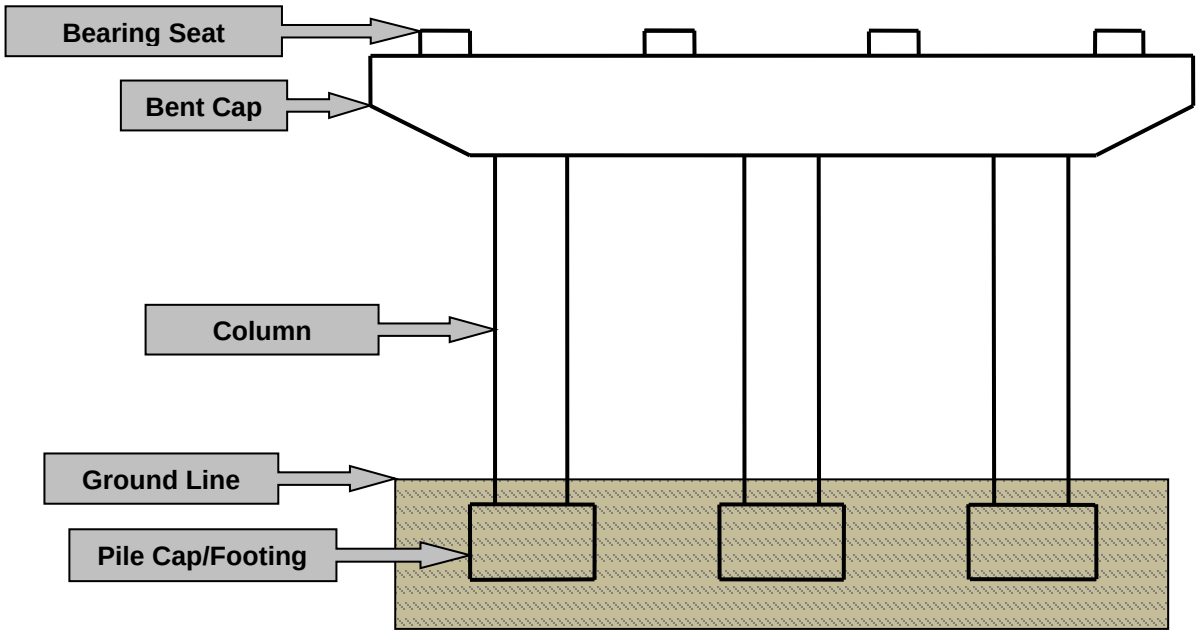
- **Backing planks (abutment face and wingwalls**): The backing planks retain the abutment backfill and transfer earth pressure forces to the piling. Element #216 (Timber Abutment) should primarily reflect the condition of the backing planks but should also reflect the overall structural condition of the abutment. This is a linear feet (LF) item, measured across the front face of the abutment, including the length of any timber wingwalls. Backing planks should be inspected for bulging, gaps, or voided backfill. There should be some backing planks below the ground line. If the bottom backing plank is exposed (due to erosion of stream degradation), the abutment backfill cannot be properly retained.

- **Bearing cap:** The bearing cap provides a bearing seat for the superstructure and transfers superstructure loads to the piling. Element #235 (Timber Pier Cap) should be used to rate the condition of the abutment bearing cap. This is a linear feet (LF) item, measured along the length of the cap. The total element quantity should include the abutment caps as well the pier caps (if there are any). Note: If the cap is comprised of another material (such as steel or concrete), the appropriate structural element should be selected. If the cap is not bearing properly on the pilings (twisted, offset, or gap), this should be reflected in the cap element rating.

- **Pile:** Pilings transmit superstructure loads from the bearing cap into the surrounding soil. Most timber abutments are supported by timber pile. A timber pile is a cylindrical shaft (typically 12” to 16” in diameter) driven into the ground using a pile hammer. Some timber abutment piling incorporates steel cable tie-back systems to resist the horizontal force resulting from earth pressure. Element #228 (Timber Pile) should be used to rate the condition of the abutment (and wingwall) piling. This is an “each” item – the total element quantity includes all timber piling on the bridge (abutment, wingwall, and piers). Note: If the abutment piling is comprised of another material (such as steel or concrete), the appropriate piling element should be selected. Free-standing vertical supports (not driven in the ground with a hammer) should be rated using a column element. Timber columns (Element #206) typically have a square or round cross-section.

7.1.5 Concrete Column Bents

The most common interior support configuration is a reinforced concrete column bent, which is comprised of two or more columns (bearing on footings), which support a bent cap. These bents are typically cast-in-place and are tied together with steel reinforcement to create a rigid frame.



Typical Concrete "Column Bent" Configuration

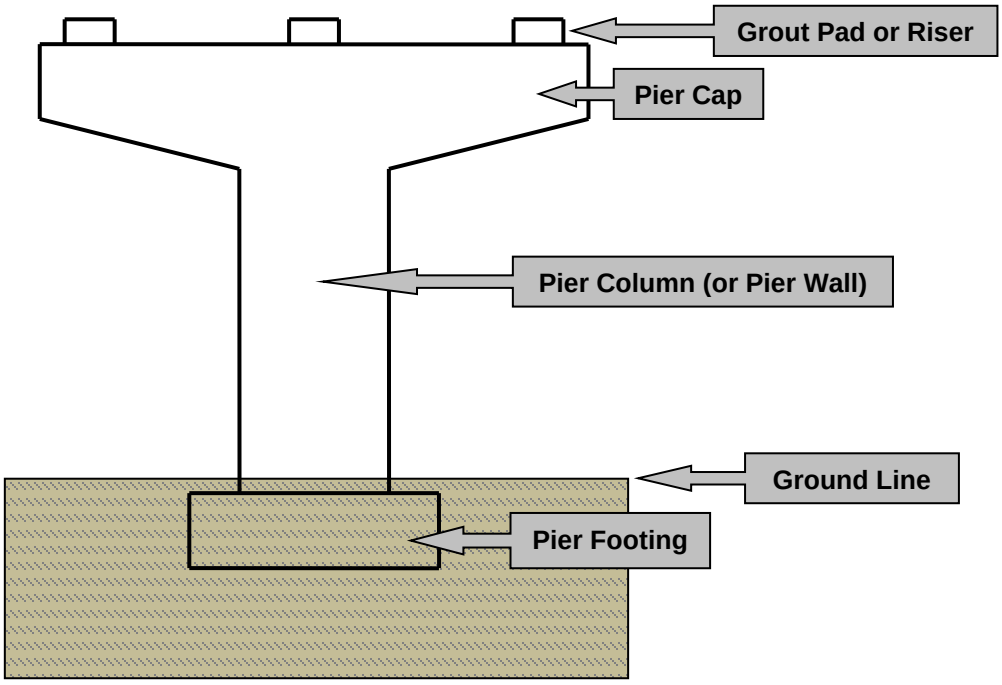
- **Bent cap:** The bent or pier cap is the upper horizontal portion of the pier that supports the superstructure. Bent caps are subjected to bending and shear forces, with bending forces often controlling the design. The bent cap (including the bearing seats) is rated using Element #234 (Reinforced Concrete Pier Cap). This is a "linear foot" quantity, measured along the length of the cap.
- **Columns:** The vertical columns transfer the superstructure load from the pier cap to the pier footing – they are primarily subjected to compression forces. Columns are rated using Element #205 (Reinforced Concrete Column). This is an "each" item, a condition rating must be determined for each specific column. Crash struts (or barriers) between the bent or pier columns should be noted.
- **Pile Cap:** As most column footings are designed to be located below grade (not visible for inspection), they are typically not rated. If footings are exposed by scour or streambed degradation, it should be brought to the attention of the agency Program Administrator (and bridge owner). Concrete footings that are visible for inspection should be rated using Element #220 (Reinforced Concrete Pilecap/Footing).

General inspection procedures for concrete bents/piers:

- Note concrete deterioration (cracking, leaching, rust staining, delamination, or spalling).
- Note evidence of deck joint leakage (staining on the cap or debris on the bearing seat).
- Note any evidence of settlement, tipping, rotation, or other movement.
- If the bent is submerged in water, the perimeter should be probed for evidence of scour, undermining, or footing/piling exposure (refer to the underwater inspection report, if applicable).
- Note the presence and condition of any protection components (such as dolphins, fenders, or crash struts).

7.1.6 Concrete Hammerhead Piers

A reinforced concrete hammerhead pier consists of a single column with a relatively wide cantilevered pier cap (the cap is typically tapered in depth).



Typical "Hammerhead" Pier Configuration

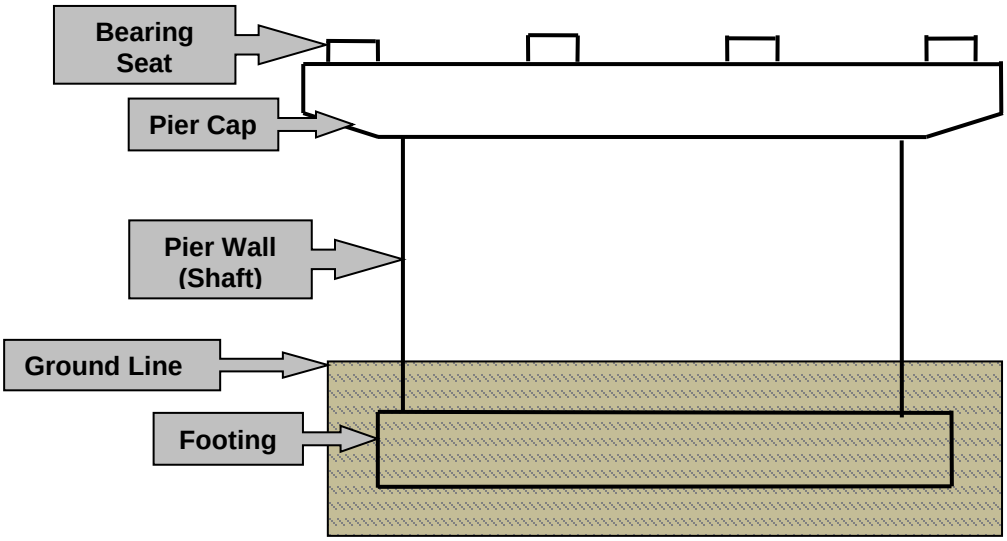
- **Pier Cap:** Element #234 (Reinforced Concrete Pier Cap) should be used to rate the cap and bearing pedestals – this is a linear foot (LF) quantity (measured along the length of the cap). The cantilever portion of the cap should be examined for any evidence of structural distress (such as shear cracking).

- **Pier Column or Pier Walls:** The vertical portion of a hammerhead pier could consist of a column or pier wall. Element #205 (Reinforced Concrete Column) will typically be used to rate columns – this is an "each" item. If the vertical support is 10 ft. or greater in width, it should be rated using Element #210 (Reinforced Concrete Pier Wall) – this is a LF item.

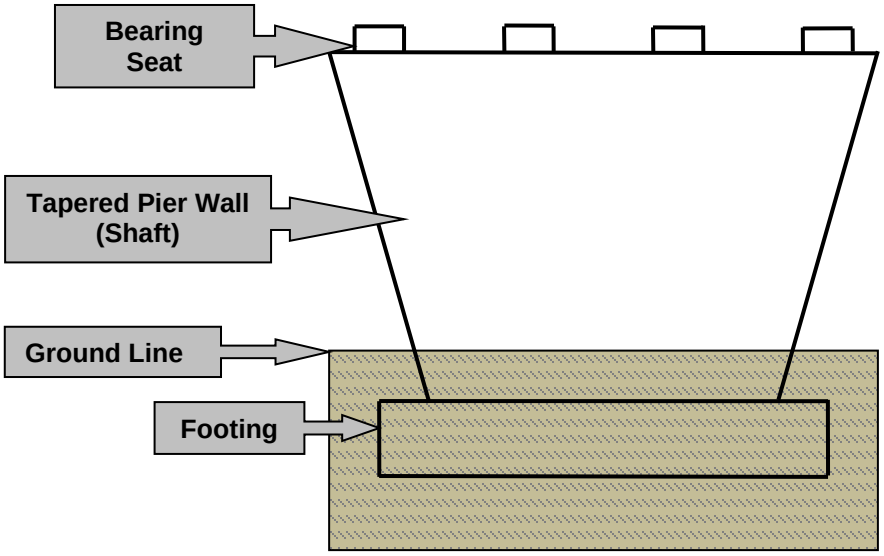
- **Pier Footing:** As the pier footing (and pilings) are typically located below grade and not visible for inspection, they are not rated as a structural element.

7.1.6 Concrete Pier Walls

A reinforced concrete pier wall is comprised of a solid shaft (as opposed to separate columns). The shaft may be straight (vertical) or tapered. There may or may not be a pier cap.



Concrete Pier Wall – Straight (Vertical) Shaft with Pier Cap

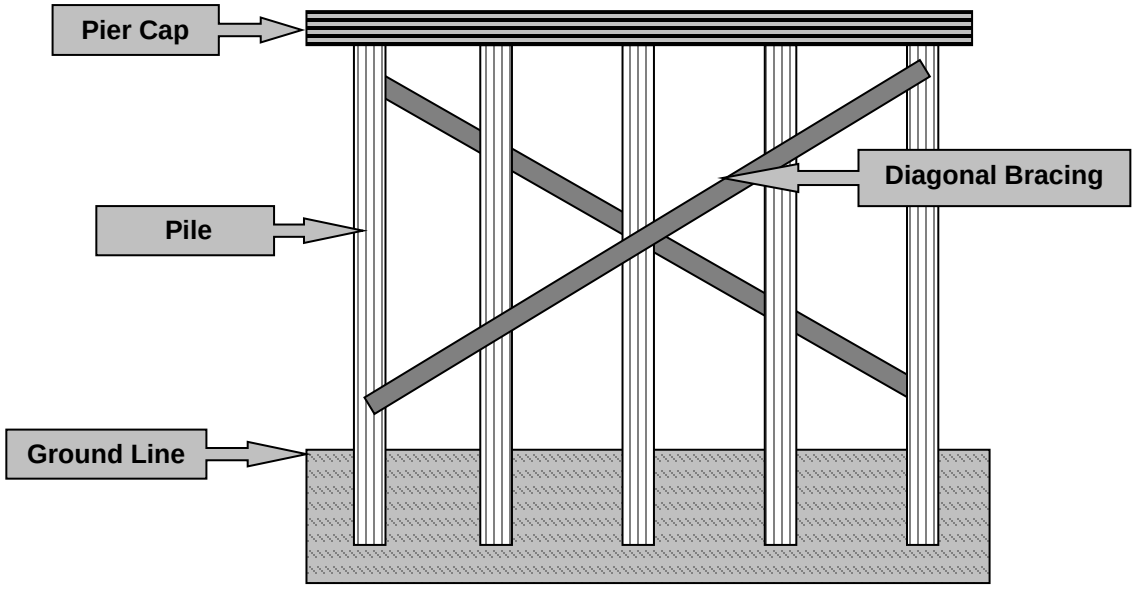


Concrete Pier Wall – Tapered Shaft without Pier Cap

- Element #210 (Reinforced Concrete Pier Wall) should be used to rate the pier wall shaft. This is a linear feet (LF) quantity (measured horizontally along the face of the pier wall (on tapered pier walls, use the widest dimension). As a general rule, pier shafts less than 10 ft. long should be rated using Element #205 (Concrete Column).
- If a pier cap is present, Element #234 (Reinforced Concrete Pier Cap) should be used to rate the cap and bearing seats. If no cap is present, the bearing seats can be included with Element #210 (Reinforced Concrete Pier Wall). As pier footings are typically below grade and not visible for inspection, they are not rated.

7.1.7 Pile Bents (Timber, Steel, or Concrete)

Substructures comprised of two or more piling supporting a cap are known as pile bents. While typically comprised of timber, they may include steel or concrete members. The inspector should determine the condition of each element, as well as the overall orientation and stability of the pier. The presence of failed connections or misaligned members should be reflected in the element ratings.



Pile Bent

- **Piling:** Pier piling transmit the superstructure load from the pier cap to the supporting soil (they are mainly subjected to compression forces). Piling should be examined for impact damage or deterioration, particularly along the waterline or ground line. SDDOT has four piling elements – they are all "each" items, a single condition rating must be determined for each pile.
    - **#225: Steel Piling (Includes H-pile and CIP Piling)**
    - **#226: Prestressed Concrete Piling**
    - **#227: Reinforced Concrete Piling**
    - **#228: Timber Piling**

- **Pier Cap:** The pier cap provides a bearing seat for the superstructure, and transfers the superstructure loads to the piling. The connections between the cap and piling should be examined for any deterioration or distress. The cap material on pile bent piers may differ from the piling material. Pier cap elements are all "LF" items, measured along the length of the cap.
    - **#231: Steel Pier Cap**
    - **#234: Reinforced Concrete Pier Cap**
    - **#235: Timber Pier Cap**

- **Pier Bracing:** To prevent pile buckling, pile bent piers are often reinforced with diagonal bracing. The bracing members should be examined for deterioration, impact damage, or connection failure.

8. SMALL UNMANNED AIRCRAFT SYSTEMS (SUAS)

All sUAS usage performed in the State of South Dakota must adhere to the following:

- Code of Federal Regulations (CFR) Title 14, Chapter I, Subchapter F, Part 107
- South Dakota Codified Law (SDCL) Title 50, Chapter 15
- SDDOT UAS Procedures Document
- SDDOT UAS Guidelines Document

The sUAS remote pilot in command (RPIC) must follow all Federal, State, and Local regulations. It is important to note that regulations can differ, and to ensure all RPIC's are following the correct regulation, SDDOT requires the RPIC follow the most restrictive regulation.

The SDDOT recognizes that the use of sUAS is an emerging access inspection method. The use of sUAS is allowed to be the primary access method on every other non-NSTM structure inspection for 12-month or 24-month cycles. For 48-month cycles, sUAS is a secondary access method. If there is any part of the structure that is a NSTM, then sUAS will be the secondary access method and a "hands-on" method will be the primary. Some examples of this are:

- A girder bridge over water on a 24-month inspection frequency.
    - 2023 sUAS is the primary access method and in 2025 a UBIV is the primary access method.
- A girder bridge over a railroad on a 12-month inspection frequency.
    - 2023 sUAS is the primary access method and in 2024 a UBIV or aerial lift is the primary access method.

Unless otherwise stated, consulting, contracting, or engineering firms working on State, LGA, or city bridge projects with DOT oversight will have flight requirements waived by the contract hiring manager provided the following is available to the hiring manager for each RPIC if requested:

- Pilot's Part 107 license number
- Date of latest reissuance of Part 107 license number, if applicable
- Approximate number of flight hours
- A summary list of locations of the individual pilot's flights/projects

Appendix A has the latest SDDOT UAS Procedures and Guidelines documents.

9. SCOUR

All bridges in South Dakota should have soundings performed and a channel profile created across the entire length of the bridge crossing a waterway at every routine NBI inspection. The reference point should be clearly marked on the channel profile drawing or sketch. Over time, these profiles can be compiled and compared against different years. This will allow the inspector to determine different creek or river characteristics such as migration, degradation, aggradation, contraction scour, etc. The characteristics gained from the profiles and observations from the current inspection will give the inspector a better insight into the creek or river and allow them to give better recommendations for protection of the structure if necessary.

11.1 SCOUR CRITICAL STRUCTURES

All structures in South Dakota labeled as scour critical should be monitored during high-water events according to the established Plan of Action (POA) for that structure. The POA should have the monitoring height and the monitoring frequency recorded to give direction to the bridge owner when an event occurs. The POA should also have an established closure elevation or closure guidance, preferably a pre-established detour route, and guidelines for re-opening the structure.

Appendix D has some established directions, example monitoring log, an example filled out POA, and an example completed monitoring log for documenting conditions during a high-water event.

12. MEASURING VERTICAL AND HORIZONTAL MEASUREMENTS

Clearance measurements at highway and railroad structures are required by the NBIS and are also used for permitting oversized loads on South Dakota highways. Measurements should be collected at regular intervals as required by FHWA, SDDOT, or local government entities. Interim inspections may also be necessary when any construction work at a structure causes a change in the horizontal or vertical clearances. These new clearances and measurements should be measured and reported, preferably, before the site is re-opened to traffic. SDDOT will be collecting vertical and horizontal clearances following the SNBI. There will be one additional horizontal clearance measured and recorded (formerly 47.03/47.04 – Horizontal Clearance Right and Left).

13.1 VERTICAL MEASUREMENTS

Vertical measurements must be collected at all routine NBI inspections. All vertical measurements are to be rounded down to the nearest 0.1 FT for reporting purposes The following are recommended locations or as required in the SNBI manual:

- Travel lane edges.
- Edge of the roadway, including the shoulder.
- Any objects hanging below the bottom of the slab or girder (signs, bolted field splices, bent caps, haunches, etc.).
- Front side of curbs.
- Front side of guardrail.
- Top of each individual rail for railroads.

There should be a minimum of three vertical clearance measurements. Additional recommended locations for vertical clearance measurements are shown in the figures later in this section. Measurements should be checked at the recommended locations and to two feet on either side of the outer clearance location or edge line to account for vehicle overhang.

13.2 HORIZONTAL MEASUREMENTS

Horizontal measurements are to be rounded down to the nearest 0.1 feet for reporting purposes. Horizontal measurements should be collected at the following locations or as required in the SNBI manual:

- Horizontal distance of individual lanes.
- Horizontal distance in-between lanes and the edge of the pavement (if in place).
- Horizontal distance from a recommended location to the point of a low hanging object.
- Horizontal distance from the outside lane edge to vehicle obstacles/obstructions (curbs, barriers, guardrail, columns, pier walls, pier caps, bent caps, and berms).
- Horizontal measurements from the lane edge to the center of the median column or pier/bent cap if the roadway is on a freeway or divided highway.

13.3 DOCUMENTATION

A clear and detailed drawing or sketch showing the vertical and horizontal measurements is required for the bridge file. The orientation of the measurements shall be clearly noted on the sketch. Preliminary results may be given verbally to the owner or owner's representative, but final documentation must be submitted to the owner of the structure in a timely manner.

13.3.1 SDDOT Inspectors

Changes in vertical clearances and horizontal measurements shall be reported to the following individuals:

- Bridge Management Engineer – Office of Bridge Design
- Operations Maintenance Engineer – Operations Support Office
- Bridge Maintenance Engineer - Office of Bridge Design
- Program Assistant – Operations Support Office
- Region Traffic Engineer
    - Only necessary if the actual vertical clearance measurements are less than 15'-3", the Region Traffic Engineer will coordinate the low clearance signing installation or changes for the in-place signs.

Changes that occur to bridges over highways that are closed to traffic will be measured by the Region Bridge Engineer or their designee. Communication with the Area Office or Maintenance Unit will be necessary for the Region Bridge Engineer to be made aware of work that affects clearances, so arrangements can be made for new clearances and measurements prior to the completion of the work (Follow DOT policy OS-OC-19.0 or its successor).

Changes in vertical clearances that occur to bridges over highways that are open to traffic during a construction or maintenance project will be estimated and provided to the above individuals by the Region Bridge Engineer or their designee prior to construction or maintenance work occurring. Once the project is complete, the Region Bridge Engineer, or their designee, will notify those individuals of the new actual vertical and horizontal clearances and measurements (Follow DOT policy OS-OC-19.0 or its successor).

Any requests for clearance data by outside entities are to be first routed through the SDDOT Legal Office and the Office of Bridge Design.

13.3.2 Consultants, Contracting, or Engineering Firms

Changes in vertical clearances and horizontal measurements that occur to bridges over roadways, railroads, or highways shall be promptly provided to the owner of the structure.

13.4 REPORTING & CODING

Vertical and horizontal measurements must be coded into the SDDOT BrM system. Below are the typical use cases.

13.4.1 Roadways with Two Way Traffic

The following field will be used in addition to the SNBI clearances:

- Beneath horizontal clearance right. Consists of the sum of the following:
    - Horizontal distance of the closest object right (including guardrail, curb, or barrier) from the edge or fog line.
    - Horizontal distance of the closest object left (including guardrail, curb, or guardrail) from the lane edge.
    - Sum of the horizontal distance of each individual lane width.

13.4.2 Divided Highways – North Bound or East Bound

The following field will be used in addition to the SNBI clearances:

- Beneath horizontal clearance right. Consists of the sum of the following:
    - Horizontal distance of the closest object right (including guardrail, curb, or barrier) from the lane edge.
    - Horizontal distance of the closest object left (including guardrail, curb, or barrier) from the lane edge.
    - Sum of the horizontal distance of each individual lane width.

13.4.3 Divided Highways – South Bound or West Bound

The following fields will be used in addition to the SNBI clearances:

- Beneath horizontal clearance left. Consists of the sum of the following:
    - Horizontal distance of the closest object right (including guardrail, curb, or barrier) from the edge or fog line.
    - Horizontal distance of the closest object left (including guardrail, curb, or barrier) from the edge or fog line.
    - Sum of the horizontal distance of each individual lane width.

13.4.4 Roadways with One Way Traffic

The following fields will be used in addition to the SNBI clearances:

- Beneath horizontal clearance right. Consists of the sum of the following:
    - Horizontal distance of the closest object right (including guardrail, curb, or barrier) from the edge or fog line.
    - Horizontal distance of the closest object left (including guardrail, curb, or guardrail) from the lane edge.
    - Sum of the horizontal distance of each individual lane width.

13.4.5 Railroads

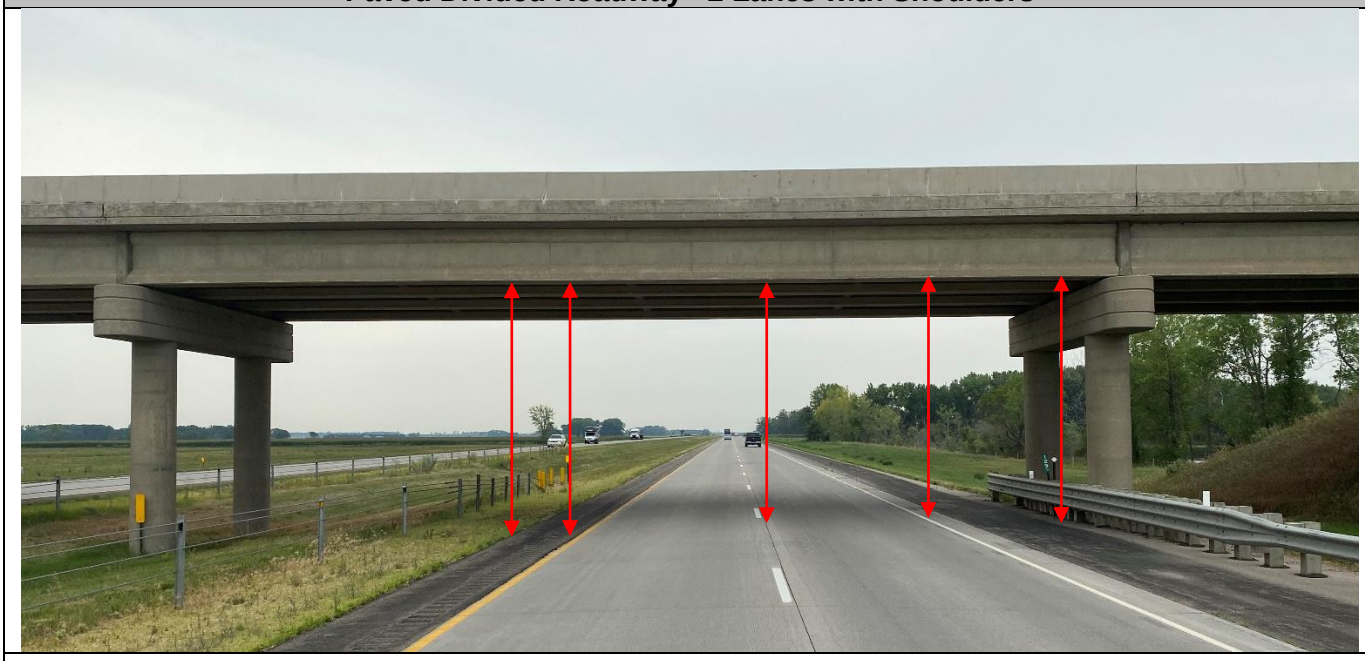
- Follow the SNBI clearances.

13.4.6 Trusses

- Follow the SNBI clearances.

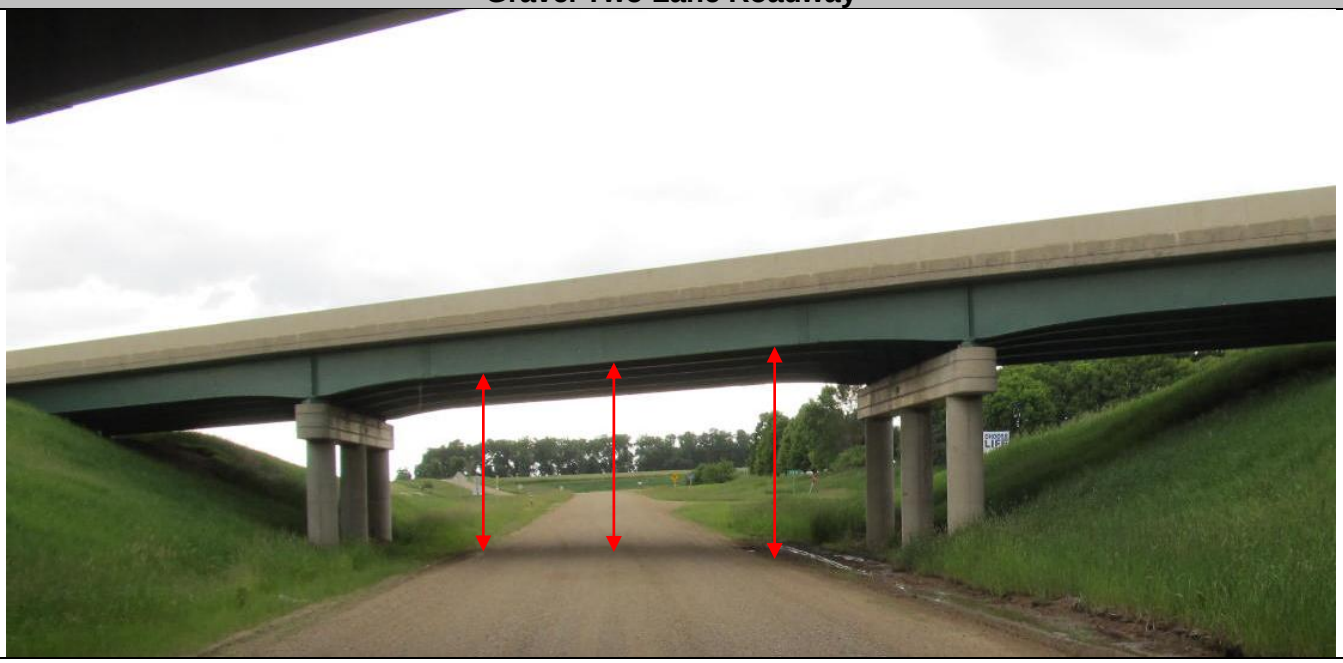
13.4.7 Vertical Clearance Examples *(need to confirm these follow SNBI)*

Paved Divided Roadway– 2 Lanes with Shoulders



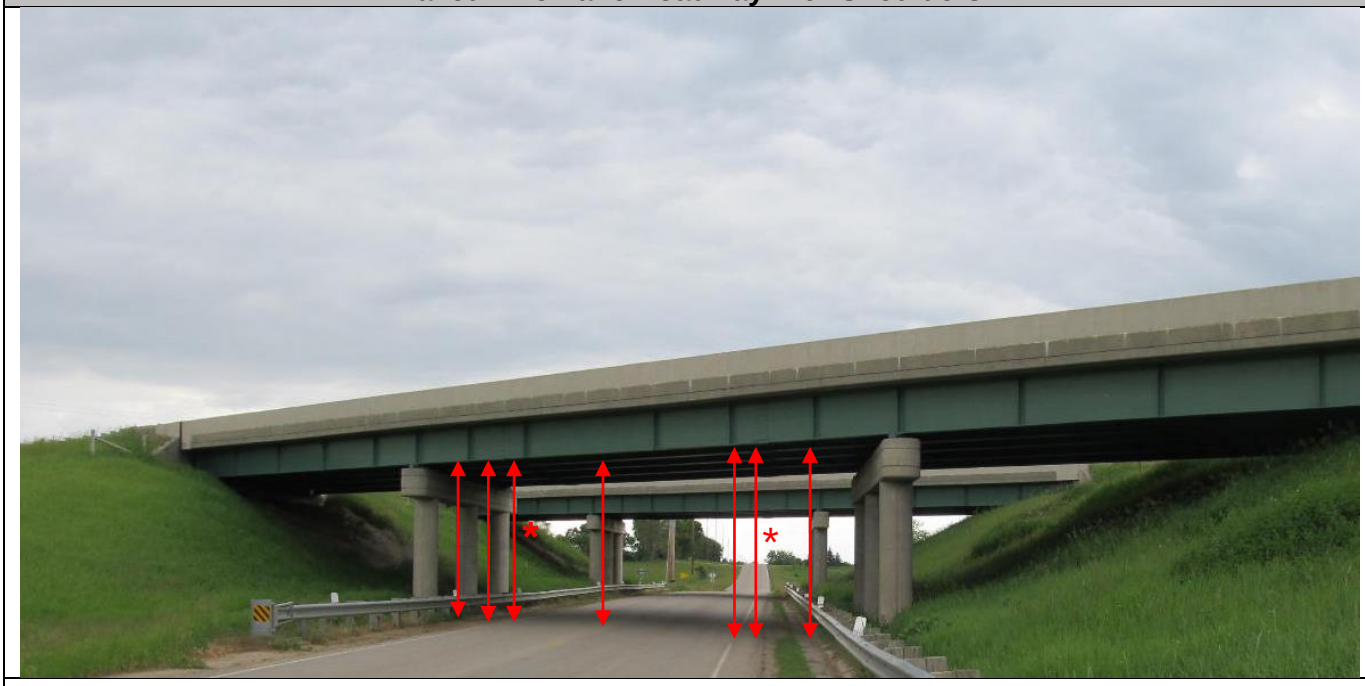
- **Recommend locations are in red.**

Gravel Two Lane Roadway



- **Recommended locations noted in red.**
- **Inspector will have to try and determine where the edges of the roadway are.**
- **Additional measurements may be required depending on the width of the roadway.**

Paved Two Lane Roadway with Shoulders

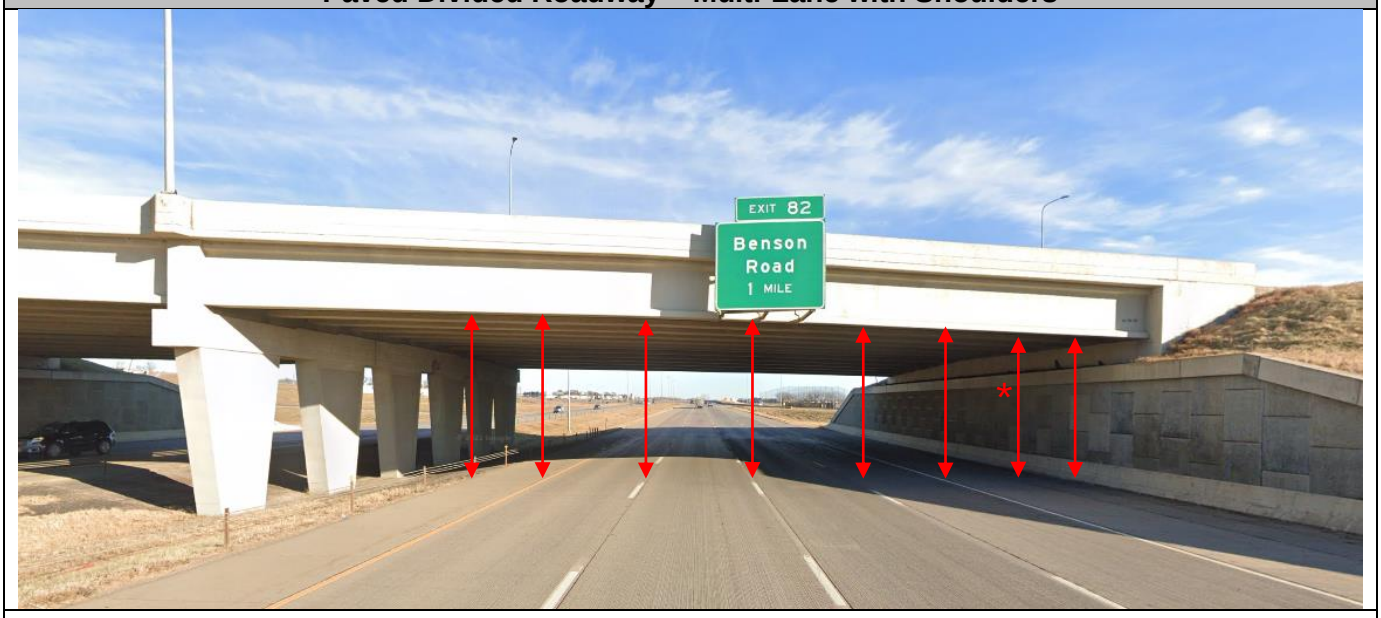


- **Recommended locations noted in red.**
- **Locations noted with * are a discontinuity (bolted field splice).**

Through Truss – Portals and Sway Bracing

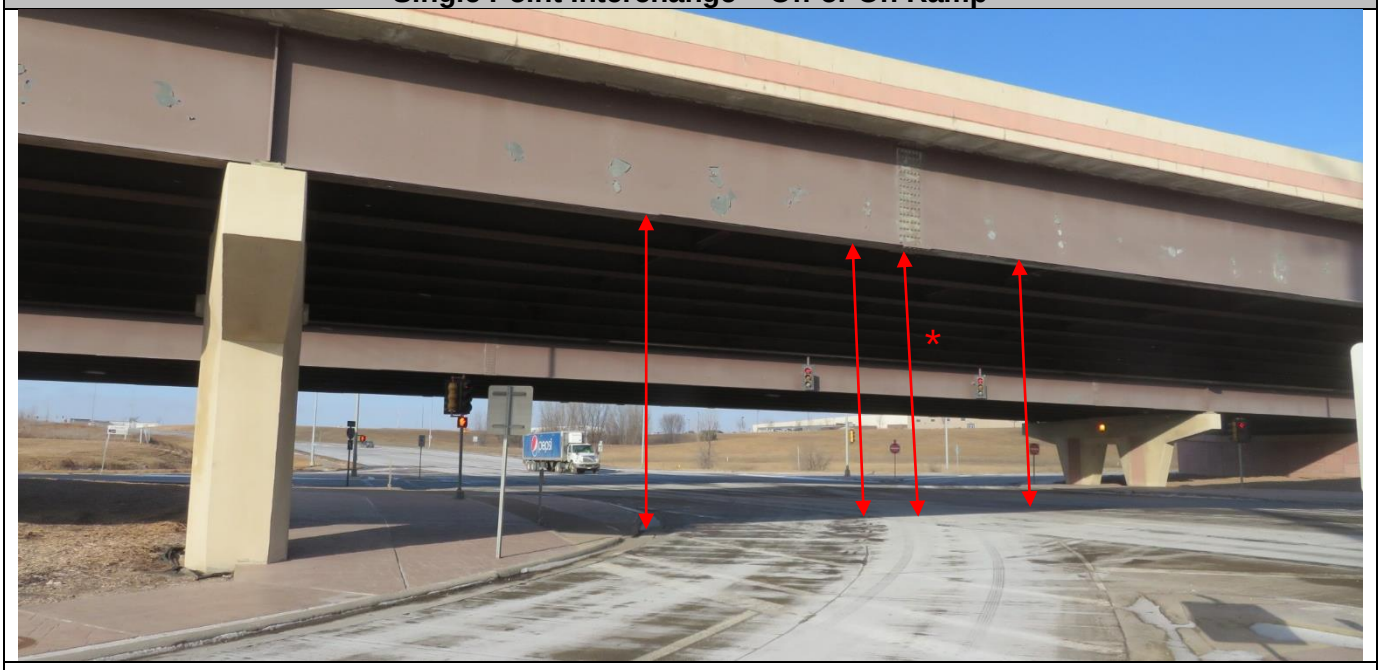
- **Recomenned locations noted in red.**
- **All portals and sway bracing should be checked.**

Paved Divided Roadway – Multi-Lane with Shoulders



- **Recommended locations noted in red.**
- **Locations noted with * are optional (recommended for a shoulder 10’ or wider with a seam or drainage path).**

Single Point Interchange – Off or On Ramp



- **Recommended locations noted in red.**
- **Locations noted with * are a discontinuity (bolted field splice).**

APPENDIX A

SDDOT UAS Procedures

SDDOT UAS Guidelines

SD DEPARTMENT OF TRANSPORTATION

Department of Transportation
700 E Broadway Avenue
Pierre, South Dakota 57501-2558
O: 605.773.5105| F: 605.773.2804
dot.sd.gov

TO: South Dakota Department of Transportation

FROM: UAS Committee

DATE: October 23, 2020

SUBJECT: Unmanned Aircraft System (UAS) Procedures

Approval Process

Procurement

A. Refer to the Guidelines document concerning procuring a UAS.

Contractors

A. Notification provided to project engineer.
B. Refer to the Consultant Service Manual.

Purpose of Use

A. Permitted UAS use includes but is not limited to; aerial photography, photogrammetry, bridge inspection, planning, geotechnical field investigations, Light Detection and Ranging (LiDAR) applications, public outreach, mapping construction sites, asset management, asset inspections, traffic monitoring, incident management, disaster response, and training exercise.
B. The purpose of each flight will be documented in the pilot log.

Documentation and Data Retention

A. All data derived from internal UAS use, contracted UAS service providers or for the Department use through projects will be maintained according to the Department policies.
B. All raw data may be stored on the SDDOT state server including data, images, video, and metadata captured.
C. All processed data may be stored on SDDOT servers.

Roles and Responsibilities

Division Director

- Provide approval or disapproval for all UAS purchase requests in their respective division after review by the UAS Committee.
- Provide approval of UAS Procedures.

UAS Committee

- Support all agency owned UAS.
- Annually review and update the UAS Procedures.
- Review submitted UAS Forms and provide a recommended action.

- Facilitate training as needed.
- Maintain a list of licensed and trained pilots.
- Maintain a list of UAS Examiners.
- Review flight plans for compliance with FAA regulations when requested.
- Maintain a list of department owned UAS equipment.
- Reviews COA requests and the need for waivers.
- Submit new COA request to the FAA for approval
- Annually review COA's which have been approved by the FAA.
- Review the UAS purchase proposals and provide a recommendation on whether to purchase to Division Director or designee

Area Engineer or Program Manager

- Designate an individual(s) to update and maintain UAS equipment

DOT Pilots

Remote Pilot in Command (RPIC) will adhere to the following requirements:

Federal Law

A. The RPIC will use the UAS in accordance with Title 14 of the Code of Federal Regulations (CFR) Part 107.
B. The RPIC is responsible for obtaining a Certificate of Waiver when UAS operations will not be in accordance with Part 107 prior to flying the UAS.

STATE LAW

A. The RPIC will adhere to all state laws including those in Title 50, Chapter 15.

Protection of Privacy

A. The RPIC will limit operations to the specific purpose of the project and employ reasonable precautions to avoid capturing images of the public except those that are incidental to the project.
B. The RPIC will complete a thorough review of the flight plan prior to flight to determine if privacy is a concern.

Safety Requirements

A. All UAS flights require a flight plan, see Steps for Use section.
B. The UAS maintenance log must be reviewed and accepted by the RPIC prior to any UAS flight.
C. The flight area will be reviewed using a preflight planning application to ensure flight is not prohibited in the area prior to any UAS flight.
D. A preflight inspection of the UAS by the RPIC is required prior to takeoff to ensure the UAS is airworthy.
E. A post flight review by the RPIC is required to document any problems or deviations from the original flight plan. Deviations will also be documented in the pilot's log.
F. A post flight inspection of the UAS is required to be conducted by the RPIC to document any damage to the UAS or required maintenance needed subsequent to the flight. Any needs should be documented in the maintenance log and relayed to the person designated by the Area Engineer or Program Manager

Training Requirements

A. UAS operations will be conducted by a trained RPIC as required by FAA and Part 107.
B. The RPIC will maintain a Remote Pilot Certificate from the FAA.
C. The RPIC will register with the UAS Committee.
D. Prior to operating any UAS for Department business, the RPIC must conduct a minimum of two hours of flight time training in an UAS training area to develop UAS proficiency for each model of aircraft that will be flown.
    a. A licensed and trained UAS pilot will identify UAS training areas where training and proficiency checks can be accomplished in a safe manner.
E. The RPIC is required to complete a proficiency check with a UAS Examiner prior to their first flight outside a training area.
F. The RPIC will undergo a pilot proficiency check consisting of aeronautical knowledge areas, areas of operations and tasks required for safe operation every 24 months for each UAS model to operated.

Accident Reporting

All accidents involving UAS that result in any injury or property damage shall be reported to the RPIC's supervisor.

All accidents involving UAS that result in serious injury, loss of consciousness, or property damage of at least $500 must be reported by the RPIC to the FAA as required in FAA Part 107 regulations.

All accidents involving UAS that meet any of the following criteria must be reported by the RPIC to the NTSB as required in Title 49 Part 830.5:

A. Accidents resulting in serious injury or death.
B. The aircraft has a maximum gross takeoff weight of 300 pounds or greater and sustains substantial damage.
C. Flight control system malfunction or failure: For an unmanned aircraft, a true "fly-away" would qualify. A lost link that behaves as expected does not qualify.
D. Inability of any required flight crewmember to perform normal flight duties as a result of injury or illness. Examples of required flight crewmembers include the pilot, remote pilot; or visual observer if required by regulation. This does not include an optional payload operator.
E. Inflight fire, which is expected to be generally associated with batteries.
F. Aircraft collision in flight.
G. More than $25,000 in damage to objects other than the aircraft.
H. Release of all or a portion of a propeller blade from an aircraft, excluding release caused solely by ground contact.

It is the RPIC's responsibility to understand and comply with all FAA and NTSB reporting requirements. All accidents reported to the FAA or NTSB shall also be reported to the UAS Committee and the Office of Aeronautics as soon as practical.

UAS Equipment

A. All UA will be registered with the FAA and display the appropriate markings as required.
B. All UAS equipment will require an identification number.
C. Equipment malfunctions will be brought to the attention of the individual designated by the Area Engineer or Program Manager and documented in the maintenance log.

UAS Maintenance

A. All UAS equipment will be properly maintained according to the manufacture's recommendations and will undergo a preflight and post flight inspection along with an annual inspection.
B. All maintenance and annual inspections will be documented in the maintenance log for the each individual UAS equipment.
C. The UAS maintenance log will document at a minimum the following information: UAS identification number, date, inspection performed, maintenance performed, damage or malfunctions incurred during operation, repairs made and additional notes or comments.

Steps for Use

The RPIC will:

- Establish a flight plan that includes at a minimum:
  - Airspace review
  - Conduct weather assessment
  - Area to be flown
  - Limitations
  - Obstacle clearance
  - Purpose of flight
  - Anticipated date and time of flight
  - Expected duration of flight
  - Communication plan
  - Emergency/contingency procedures
  - Anticipated UAS project crew members
- Check out UAS equipment from Area Engineer or Program Manager or their designee
- Complete preflight checklist
- Complete post flight checklist after flight.
- Transfer all data, images, video, and metadata captured on to a SDDOT state server and use SDDOT naming conventions as required
- Return UAS equipment to Area Engineer or Program Manager or designee and communicate any UAS malfunctions, damage incurred, and maintenance and/or repairs needed.

General Flight Requirements

UAS operations shall be in accordance with Part 107 which includes these and other requirements:

A. Visual line-of-sight (VLOS): the UAS must remain in VLOS of the RPIC or visual observer.
B. Location: UAS may not operate over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle.
C. Allowed flight times: flight can be accomplished during daylight or civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting.

D. Battery life: flight must be conducted with enough remaining battery to ensure safe landing at the home point or the alternative landing point identified in the flight plan and with enough reserve battery life to ensure safe landing at the alternative site if landing at the home site is not possible.
E. Weather visibility: the minimum weather visibility distance is three miles from your control station.
F. Flight altitude: the maximum flight altitude is 400 feet above the ground and higher if the UAS remains within 400 feet of a structure unless otherwise directed by LAANC (Low Altitude Authorization and Notification Capability system) authorization.
G. Flight speed: the maximum flight speed is 100 mph (87 knots).

Consequences of Misuse

Unauthorized uses can result in legal action by third parties, loss of authorization to operate UAS for the department, and/or discipline up to and including termination.

Department of Transportation
700 E Broadway Avenue
Pierre, South Dakota 57501-2558
O: 605.773.5105| F: 605.773.2804
dot.sd.gov

Unmanned Aircraft System (UAS)

Effective Date: 10/23/2020

Purpose

To define the use of Unmanned Aircraft Systems (UAS) for the purpose of conducting South Dakota Department of Transportation (Department) business.

Guidelines

UAS Use

UAS may be used when it provides cost efficiency, improved data quality, or improved personnel safety over an existing method or process. UAS may be used to perform a wide range of Department functions.

Employees are prohibited from using privately owned UAS for Department business.

UAS service providers must use company owned UAS for Department business, unless under written agreement with the Department. Consultants, please refer to the Consultant Service Manual.

All UAS operations will comply with Federal Aviation Administration (FAA) Part 107 regulations involving operations, pilot certification, aircraft registration, waivers/authorizations, and airworthiness standards.

The UAS Remote Pilot in Command (RPIC) has the final authority and responsibility for the operation, safety, and FAA Part 107 regulatory compliance of any UAS operation. Employees or offices that require assistance complying with FAA regulations will consult with the Office of Aeronautics.

Aspects of these guidelines are not to be construed as to restrict the safe, rapid deployment of an agency owned or contracted UAS in response to an emergency or exigent situation to protect life and limb, critical transportation infrastructure or the environment. Emergency use shall be in accordance with FAA requirements for emergencies as noted in FAA requirements.

Operational and Training Requirements

SDDOT employees must register with the UAS Committee as Remote Pilot in Command (RPIC) prior to operating a UAS with the following information:

Name:

FAA Remote Pilot Certificate #:

Proficiency Check Date:

Model(s) of UAS Approved to Fly:

Division and Office:

Prior to operating any UAS for Department business, the RPIC must conduct a minimum of two hours of flight time training in an UAS training area to develop UAS proficiency for each model of aircraft that will be flown. The RPIC must then satisfactorily complete a Proficiency Check with the UAS examiner to demonstrate operational knowledge and proficiency.

Employees must subsequently complete a satisfactory Proficiency Check with the UAS examiner no less than once every 24 calendar months.

Department UAS flights will be tracked following the UAS Procedures.

UAS Procurement

The procurement of a Department owned UAS requires the approval of the appropriate Division Director.

The requesting Division Director or designee will submit to the UAS Committee a detailed explanation and justification for an aircraft, the intended purpose, time, manner and location of use by using the request UAS Form.

Procurement will be in accordance with applicable statutes, rules and Department procurement policies and procedures.

Safety Procedures

Employees operating a UAS will comply with the Department safety manual and FAA safety regulations. Refer to the UAS Procedures.

Protection of Individual Privacy and Personal Information

UAS RPIC will limit operations to the specific purpose of the project and employ reasonable precautions to avoid capturing images of the public except those that are incidental to the project.

Accident Reporting

All accidents involving UAS that result in any injury or property damage shall be reported to the RPIC's supervisor. Accidents meeting the reporting requirements of the FAA and NTSB shall be reported by the RPIC to the respective organization as required in FAA Part 107 and Title 49 Part 830.5. It is the RPIC's responsibility to understand and comply with all FAA and NTSB reporting requirements. All accidents reported to the FAA or NTSB shall also be reported to the UAS Committee and the Office of Aeronautics as soon as practical.

In the case of UAS service providers, notification of any reportable incident should also be made in writing, as soon as practical to their specified contact at the South Dakota DOT.

Definitions:

Certificate of Waiver or Authorization (COA)

An authorization issued by the FAA to grant NAS (National Air Space) access for a specific UAS activity. COAs contain requirements the holder must follow. The FAA issues COAs for both public UAS operations and civil UAS operations.

Flight

Each flight is required to have a flight plan. Refer to the UAS Procedures.

Remote Pilot in Command (RPIC)

A person who holds a pilot certificate with an UAS rating and has the final authority and responsibility for the operation and safety of an UAS operation conducted under part 107.

Project

A project normally has a specific purpose, timeframe and defined location. A project may require multiple flights.

Unmanned Aircraft (UA)

The flying portion of the system, flown by a pilot via a ground control system or autonomously through use of an on-board computer, communication links and any additional equipment that is necessary for the UA to operate safely.

Unmanned Aircraft System (UAS)

The UA and all the associated support items such as equipment, control station, data links, telemetry, communications and navigation equipment necessary to operate the unmanned aircraft.

Visual Observer (VO)

A person who assists the RPIC to see and avoid obstacles.

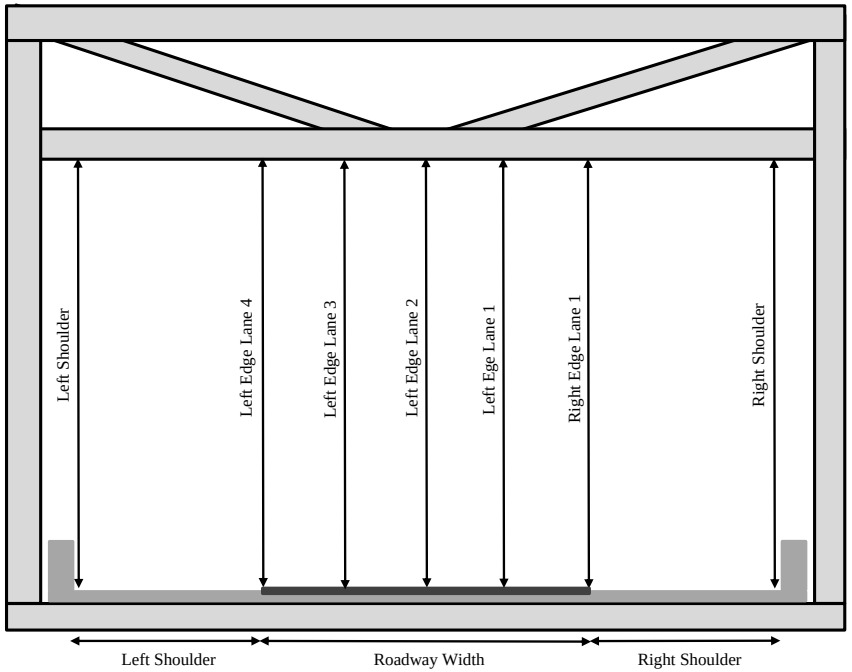
APPENDIX B

SNBI Clearance Forms

Truss Clearances

Str. No. ##-###-###

North / East Face



South / West Face

B.H.12 Maximum Usable Vertical Clearance: Minimum vertical clearance measured over the 10 foot wide envelope of the highway, excluding shoulders, that provides the maximum vertical clearance.

B.H.16 Maximum Usable Surface Width: Measure the width perpendicular to centerline (including paved or stabilized shoulders).

	Feet	Inches	Decimal
Right Shoulder:			0.00
Right Edge Lane 1:			0.00
Left Edge Lane 1:			0.00
Left Edge Lane 2:			0.00
Left Edge Lane 3 (OPT):			0.00
Left Edge Lane 4 (OPT):			0.00
Left Shoulder:			0.00

	Feet	Inches	Decimal
10' Left/ Right of Max:			0.00
Left Shoulder:			0.00
Roadway Width:			0.00
Right Shoulder:			0.00

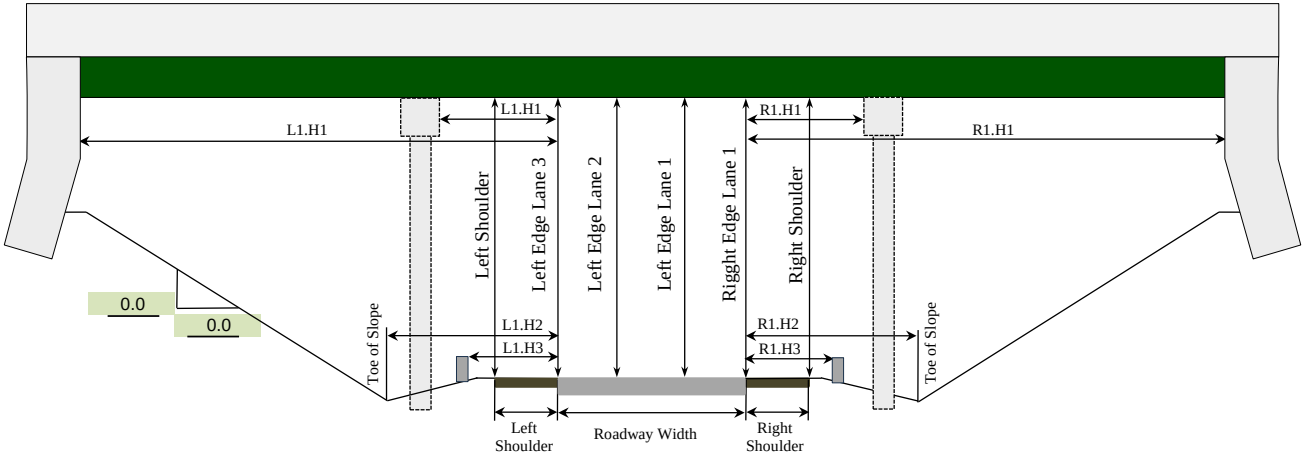
	Decimal
B.H.12 Maximum Usable Vertical Clearance:	0.0
B.H.13 Minimum Vertical Clearance:	0.0
B.H.16 Maximum Usable Surface Width:	0.0

Inspector:

Date:

Single or 3-Span Under Clearances (One Way Traffic)

Str. No. ##-###-###



	Feet	Inches	Decimal		Feet	Inches	Decimal		Feet	Inches	Decimal
L1.H1:			0.00	R1.H1:			0.00	Stabilized Left Shoulder:			0.00
L1.H2:			0.00	R1.H2:			0.00	Roadway Width:			0.00
L1.H3:			0.00	R1.H3:			0.00	Stabilized Right Shoulder:			0.00

B.H.14/ B.H.15 Minimum Horizontal Clearance: Measure from the edge of the driving lane to the nearest substructure unit, rigid barrier, oncoming traffic lane, or toe of slope that is steeper than a 1 to 3 (vertical to horizontal)
B.H.12 Maximum Usable Vertical Clearance: Minimum vertical clearance measured over the 10 foot wide envelope of the highway, excluding shoulders, that provides the maximum vertical clearance.
B.H.16 Maximum Usable Surface Width: Measure the width perpendicular to centerline (including paved or stabilized shoulders)
If shoulder is stabilized add the lengths of exterior shoulder, roadway width and interior shoulder. If shoulders are not stabilized only record width of roadway.

***** When using excel document, if a clearance is not needed/taken fill the field with 99' 0" *****

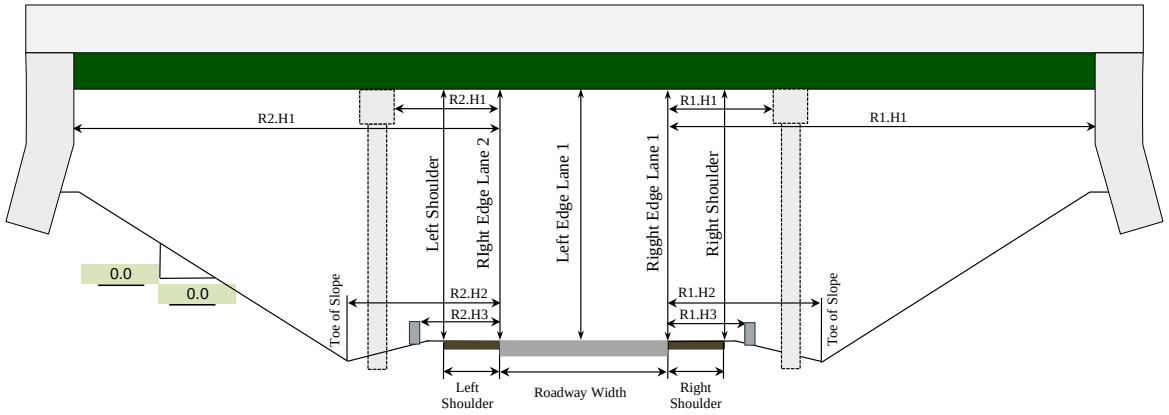
	Feet	Inches	Decimal
Stabilized Right Shoulder:			0.00
Right Edge Lane 1:			0.00
Left Edge Lane 1:			0.00
Left edge Lane 2:			0.00
Left edge Lane 3 (OPT):			0.00
Stabilized Left Shoulder:			0.00
10' Left/ Right of Max:			0.00

	Decimal
B.H.12 Maximum Usable Vertical Clearance:	0.0
B.H.13 Minimum Vertical Clearance:	0.0
B.H.14 Minimum Horizontal Clearance, Left:	0.0
B.H.15 Minimum Horizontal Clearance, Right:	0.0
B.H.16 Maximum Usable Surface Width:	0.0

Date: Inspector:

Single or 3-Span Under Clearances (Two Way Traffic)

Str. No. ##-###-###



	Feet	Inches	Decimal		Feet	Inches	Decimal		Feet	Inches	Decimal
R2.H1:			0.00	R1.H1:			0.00	Stabilized Left Shoulder:			0.00
R2.H2:			0.00	R1.H2:			0.00	Roadway Width:			0.00
R2.H3:			0.00	R1.H3:			0.00	Stabilized Right Shoulder:			0.00

B.H.14/ B.H.15 Minimum Horizontal Clearance: Measure from the edge of the driving lane to the nearest substructure unit, rigid barrier, oncoming traffic lane, or toe of slope that is steeper than a 1 to 3 (vertical to horizontal)
B.H.12 Maximum Usable Vertical Clearance: Minimum vertical clearance measured over the 10 foot wide envelope of the highway, excluding shoulders, that provides the max imum vertical clearance.
B.H.16 Maximum Usable Surface Width: Measure the width perpendicular to centerline (including paved or stabilized shoulders)
If shoulder is stabilized add the lengths of exterior shoulder, roadway width and interior shoulder. If shoulders are not stabilized only record width of roadway.
***** When using excel document, if a clearance is not needed/taken fill the field with 99' 0" *****

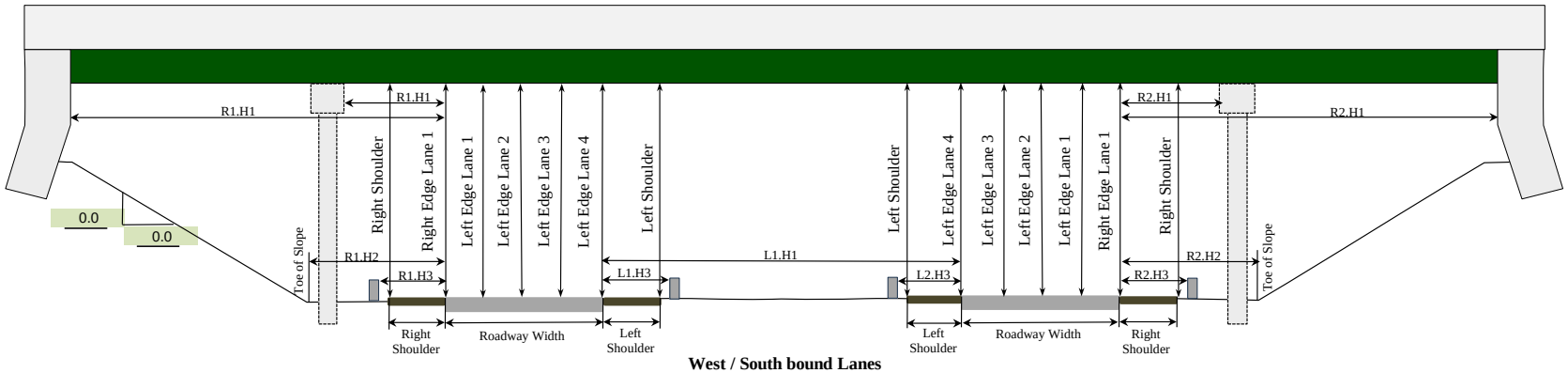
	Feet	Inches	Decimal		Decimal
Stabilized Right Shoulder:			0.00	B.H.12 Maximum Usable Vertical Clearance:	0.0
Right Edge Lane 1:			0.00	B.H.13 Minimum Vertical Clearance:	0.0
Left Edge Lane 1:			0.00	B.H.14 Minimum Horizontal Clearance, Left:	0.0
Right Edge Lane 2:			0.00	B.H.15 Minimum Horizontal Clearance, Right:	0.0
Stabilized Left Shoulder:			0.00	B.H.16 Maximum Usable Surface Width:	0.0
10' Left/ Right of Max:			0.00		

Date: Inspector:

1 or 3-Span Under Clearances

Str. No. ##-###-###

West / South bound Lanes | East/ North bound Lanes



West / South bound Lanes

	Feet	Inches	Decimal		Feet	Inches	Decimal		Feet	Inches	Decimal
L1.H1:			0.00	R1.H1:			0.00	Stabilized Left Shoulder:			0.00
L1.H3:			0.00	R1.H2:			0.00	Roadway Width:			0.00
				R1.H3:			0.00	Stabilized Right Shoulder:			0.00

East/ North bound Lanes

	Feet	Inches	Decimal		Feet	Inches	Decimal		Feet	Inches	Decimal
L2.H3:			0.00	R2.H1:			0.00	Stabilized Left Shoulder:			0.00
				R2.H2:			0.00	Roadway Width:			0.00
				R2.H3:			0.00	Stabilized Right Shoulder:			0.00

B.H.14/B.H.15 Minimum Horizontal Clearance: Measure from the edge of the outer lanes to the nearest substructure unit, rigid barrier, oncoming traffic lane, or toe of slope that is steeper than a 1 to 3 (vertical to horizontal)
B.H.12 Maximum Usable Vertical Clearance: Minimum vertical clearance measured over the 10 foot wide envelope of the highway, excluding shoulders, that provides the maximum vertical clearance.
B.H.16 Maximum Usable Surface Width: Measure the width perpendicular to centerline (including paved or stabilized shoulders)
If shoulder is stabilized add the lengths of exterior shoulder, roadway width and interior shoulder. If shoulders are not stabilized only record width of roadway.

****Measurements are taken in the direction of travel****

***** When using excel document, if a clearance is not needed/taken fill the field with 99' 0" *****

West / South bound Lanes

	Feet	Inches	Decimal		Decimal
Stabilized Right Shoulder:			0.00	B.H.12 Maximum Usable Vertical Clearance:	0.0
Right Edge Lane 1:			0.00	B.H.13 Minimum Vertical Clearance:	0.0
Left Edge of Lane 1:			0.00	B.H.14 Minimum Horizontal Clearance, Left:	0.0
Left Edge of Lane 2 (OPT):			0.00	B.H.15 Minimum Horizontal Clearance, Right:	0.0
Left Edge of Lane 3 (OPT):			0.00	B.H.16 Maximum Usable Surface Width:	0.0
Left Edge of Lane 4 (OPT):			0.00		
Stabilized Left Shoulder:			0.00		
10' Left/ Right of Max:			0.00		

East/ North bound Lanes

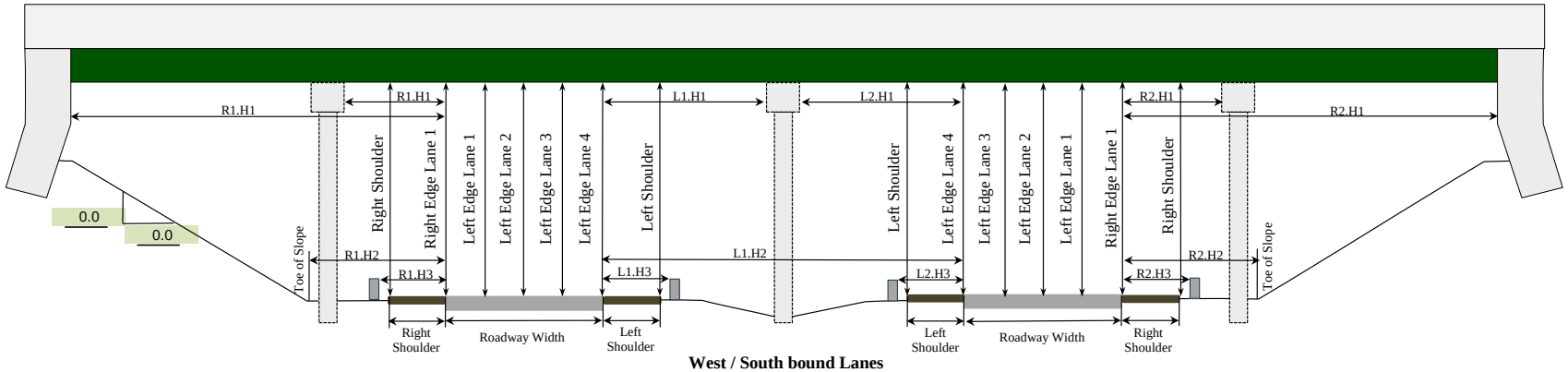
	Feet	Inches	Decimal		Decimal
Stabilized Right Shoulder:			0.00	B.H.12 Maximum Usable Vertical Clearance:	0.0
Right Edge Lane 1:			0.00	B.H.13 Minimum Vertical Clearance:	0.0
Left Edge of Lane 1:			0.00	B.H.14 Minimum Horizontal Clearance, Left:	0.0
Left Edge of Lane 2 (OPT):			0.00	B.H.15 Minimum Horizontal Clearance, Right:	0.0
Left Edge of Lane 3 (OPT):			0.00	B.H.16 Maximum Usable Surface Width:	0.0
Left Edge of Lane 4 (OPT):			0.00		
Stabilized Left Shoulder:			0.00		
10' Left/ Right of Max:			0.00		

Date: Inspector:

2 or 4-Span Under Clearances

Str. No. ##-###-###

West / South bound Lanes | East/ North bound Lanes



West / South bound Lanes

	Feet	Inches	Decimal		Feet	Inches	Decimal		Feet	Inches	Decimal
L1.H1:			0.00	R1.H1:			0.00	Stabilized Left Shoulder:			0.00
L1.H2:			0.00	R1.H2:			0.00	Roadway Width:			0.00
L1.H3:			0.00	R1.H3:			0.00	Stabilized Right Shoulder:			0.00

East/ North bound Lanes

	Feet	Inches	Decimal		Feet	Inches	Decimal		Feet	Inches	Decimal
L2.H1:			0.00	R2.H1:			0.00	Stabilized Left Shoulder:			0.00
L2.H3:			0.00	R2.H2:			0.00	Roadway Width:			0.00
				R2.H3:			0.00	Stabilized Right Shoulder:			0.00

B.H.14/B.H.15 Minimum Horizontal Clearance: Measure from the edge of the outer lanes to the nearest substructure unit, rigid barrier, oncoming traffic lane, or toe of sl ope that is steeper than a 1 to 3 (vertical to horizontal)
B.H.12 Maximum Usable Vertical Clearance: Minimum vertical clearance measured over the 10 foot wide envelope of the highway, excluding shoulders, that provides the maximum vertical clearance.
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****Measurements are taken in the direction of travel****

***** When using excel document, if a clearance is not needed/taken fill the field with 99' 0" *****

West / South bound Lanes

	Feet	Inches	Decimal		Decimal
Stabilized Right Shoulder:			0.00	B.H.12 Maximum Usable Vertical Clearance:	0.0
Right Edge Lane 1			0.00	B.H.13 Minimum Vertical Clearance:	0.0
Left Edge of Lane 1:			0.00	B.H.14 Minimum Horizontal Clearance, Left:	0.0
Left EdgeLane 2 (OPT):			0.00	B.H.15 Minimum Horizontal Clearance, Right:	0.0
Left Edge Lane 3 (OPT):			0.00	B.H.16 Maximum Usable Surface Width:	0.0
Left Egde Lane 4 (OPT):			0.00		
Stabilized Left Shoulder:			0.00		
10' Left/ Right of Max:			0.00		

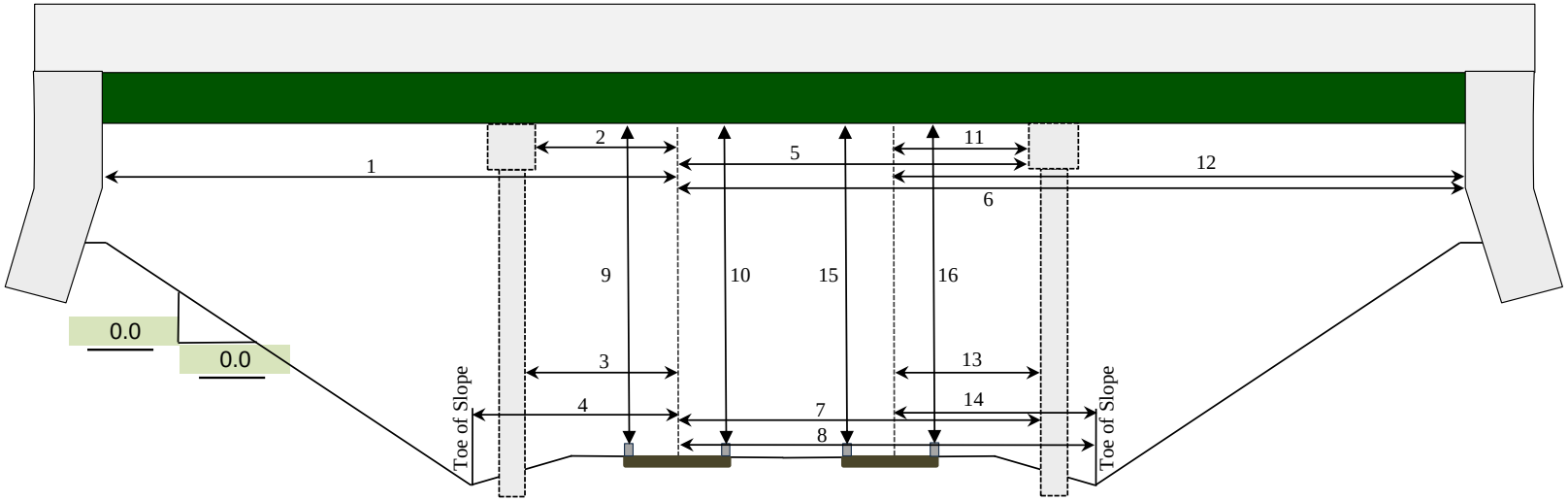
East/ North bound Lanes

	Feet	Inches	Decimal		Decimal
Stabilized Right Shoulder:			0.00	B.H.12 Maximum Usable Vertical Clearance:	0.0
Right Edge Lane 1			0.00	B.H.13 Minimum Vertical Clearance:	0.0
Left Edge of Lane 1:			0.00	B.H.14 Minimum Horizontal Clearance, Left:	0.0
Left EdgeLane 2 (OPT):			0.00	B.H.15 Minimum Horizontal Clearance, Right:	0.0
Left Edge Lane 3 (OPT):			0.00	B.H.16 Maximum Usable Surface Width:	0.0
Left Egde Lane 4 (OPT):			0.00		
Stabilized Left Shoulder:			0.00		
10' Left/ Right of Max:			0.00		

Date: Inspector:

Railroad Clearances

Str. No. ##-###-###



Track 1

	Feet	Inches	Decimal
1			0
2			0
3			0
4			0
5			0
6			0
7			0
8			0
9			0
10			0

Track 2

	Feet	Inches	Decimal
11			0
12			0
13			0
14			0
15			0
16			0

***** When using excel document, if a clearance is not needed fill the field with 99' 0" *****

Railroad Minimum Vertical Clearance (B.RR.02) 0.0

Railroad Minimum Horizontal Offset (B.RR.03) 0.0

Inspector:

Date:

APPENDIX C

Procedure for Notification of Damage to Bridges Due to Vehicle Impacts Memorandum

SDDOT Bridge System Code Manual
Critical Findings & Forms

APPENDIX C

Critical Findings

Definitions

A critical finding is a bridge or portion thereof, discovered either by bridge inspection or notification by the public, which critically threatens the structural stability and/or public safety of a bridge. The critical finding is of such severity that an immediate follow-up inspection or action may warrant temporary shoring, speed reduction, post or restrict, partial or full closure or other, until short-term and/or long-term resolutions are completed to resolve the structural and/or safety related deficiency(s).

Manual for Bridge Evaluation, Section 2: Bridge Files and Documentation
2.2.3—Critical Findings and Actions Taken
Provide a detailed description and photographs of the specific critical finding(s) sufficient to document safety or structural concerns. Identify appropriate immediate actions or follow-up inspections. Include a record of the actions taken to resolve or monitor the critical finding(s).
23 CFR 650.305 Definitions
Critical finding. A structural or safety related deficiency that requires immediate actions to ensure public safety.

23 CFR 650.313 Inspection procedures
(q) Document procedures to address critical findings in a timely manner. Procedures must define critical findings considering the location and the redundancy of the member affected and develop and document timeframes to address critical findings identified. State, Federal, and Tribal governments must inform FHWA of all critical findings and actions taken, underway, or planned to resolve critical findings.

Critical Finding Procedures

Critical Findings – State owned Bridges

Bridges that have a structural stability and/or safety related deficiency requiring immediate follow-up inspection or action. Potential events/incidents which may warrant a critical finding designation are as follows:

- Bridges with load rating changes that require load posting. When posting signs are installed the critical finding is satisfied and no updates are required.

- Full or partial closure of the bridge.

- Immediate load restriction or posting, or immediate repair work to a bridge, including shoring, in order to remain open.

- Bridges that have a SNBI Condition rating of 2 or less for Deck (B.C.01), Superstructure (B.C.02), Substructure (B.C.03), Channel (B.C.09), Scour (B.C.11), or Culvert (B.C.04).

- Nonredundant Steel Tension Member condition rating (B.C.14) coded 3 or less.

- Nonredundant Steel Tension Member Bridges (NSTM) that have a NSTM member identified as requiring immediate remedial work.

- Bridges with unknown foundations experiencing severe scour (B.SB.06 coded a U, B.C.11 coded 2 or less).

- Other Safety deficiencies (movement, natural disaster, bridge hits, etc.)

Critical Findings – Local Government Agency owned Bridges

Bridges that have a structural stability and/or safety related deficiency that requires immediate follow-up inspection or action. Potential events/incidents which may warrant a critical finding designation are as follows:

- Bridges that are recommended to be closed or load posted at less than 3 tons.

- Full or partial closure of the bridge.

- Immediate load restriction or posting, or immediate repair work to a bridge, including shoring, in order to remain open.

- Bridges that have a SNBI Condition rating of 2 or less for Deck (B.C.01), Superstructure (B.C.02), Substructure (B.C.03), Channel (B.C.09) Scour (B.C.11), or Culvert (B.C.04).

- Nonredundant Steel Tension Member condition rating (B.C.14) coded 3 or less.

- Nonredundant Steel Tension Member Bridges (NSTM) that have a NSTM member identified as requiring immediate remedial work.

- Bridges with unknown foundations experiencing severe scour (B.SB.06 coded a U, B.C.11 coded 2 or less).

- Other Safety deficiencies (movement, natural disaster, bridge hits, etc.)

Some viable options available for bridges with critical findings are permanent repair, temporary repair and monitoring, restricting loads, monitoring, or bridge closure.

Notification – State owned Bridges

1. The Inspection Team Leader discovering the critical finding shall promptly report the finding to the Region Bridge Engineer who will promptly inform the NBIS Inspection Program Manager (Program Manager) and Area Engineer. Don't rely on email. Positive notification must be verified. A determination should be made if the bridge needs to be closed immediately.
2. The Program Manager shall notify FHWA within 24 hours of discovery.
3. The Region Bridge Engineer shall complete Part 1 of the Critical Finding Report and submit a copy to the Program Manager within 48 hours of the critical finding.
4. The Program Manager shall complete Parts II and III of the critical finding report.

Notification – Local Government Agency owned Bridges

1. The Inspection Team Leader discovering the critical finding shall immediately report the finding to the responsible local official and the Local Government Bridge Inspection Engineer. Don't rely on email. Positive notification must be verified. A determination will be made if the bridge needs to be closed immediately.
2. The Local Government Bridge Inspection Engineer shall notify FHWA within 24 hours of discovery.
3. The Inspection Team Leader shall complete Part 1 of the Critical Finding Report and submit a copy to the responsible local official and the Local Government Bridge Inspection Engineer within 48 hours of the finding.
4. The responsible local official shall complete Part II of the Critical Finding Report and submit a copy to the Local Government Bridge Inspection Engineer within 3 months of the finding.
5. The responsible local official shall complete Part III when final action is taken, or update status every twelve (12) months until final action is taken and submit a copy to the Local Government Bridge Inspection Engineer.

BrM Documentation and FHWA Notification and Reporting Procedures

<u>BrM Documentation</u>

There are five different data fields on the South Dakota Bridge Inspection page that are used to help track critical findings in the BrM bridge database.

There is a checkbox that a critical finding has been identified and a drop-down list to choose why it is a critical finding. There is an additional check box for marking that the critical finding has been fixed, along with the date this was accomplished. Document details about the problem or status of the repairs in the notes field. It will be assumed that the date the critical finding was identified is the date of the inspection record or notification by the public.

Critical Findings Notification and Reporting to FHWA

1. Notify FHWA of critical findings as they are identified for State and Local Government agency bridges within 24 hours of discovery.
2. Provide FWHA a biannual critical finding report. The report will list each bridge, the custodian, county, posting status, the date of the critical finding, description of the critical finding, what action(s) is to be taken to resolve or monitor the critical finding, when the critical finding was resolved or monitoring status.

   Critical finding report categories with the documented status:

   - Bridges that have critical findings in the process of being addressed.
   - Bridges with work scheduled but not started yet.
   - Bridges that have no plan in the works, monitoring.
   - Critical Finding is scour related.

Example Critical Findings

The critical findings listed below are organized by material type and application. These deficiencies represent excerpts obtained from several agencies' critical finding documentation and are from the Bridge Inspection Reference Manual (BIRM). This list is provided for reference only. Do not assume this list includes all possible critical findings.

The following deficiencies represent examples of critical findings for timber:

- Through-loss in deck planks and broken planks in danger of breaking through.
- Primary structural members with collision damage that compromises the structural capacity (including severe section loss, full length horizontal cracking, and section loss to truss compression members producing member buckling or severe flexural cracking).
- Primary structural members with multiple open cracks in high stress regions or crushing/decay that may lead to superstructure settlement.
- Crushed or broken nailer boards or broken joists.
- Piles and pier caps that have loss of bearing capacity or soil retention through crushing, decay, or insect damage.
- Substructure units with severe scour and undermining of the substructure foundation causing instability.

The following deficiencies represent examples of critical findings for concrete:

- Section loss (thru-hole) subject to enlargement by traffic or deep spalls with exposed rebar in danger of holing through, creating a safety hazard to passing traffic.
- Prestressed girder with spalling and broken strands or 100% deterioration at critical high stress areas.
- Non-composite prestressed adjacent box beams with serious deterioration and existing strand loss, loss of camber or torsional cracking.

- Reinforced concrete girder or pier cap with spalling and broken main rebar or 100% deterioration, with more than one bar affected at the same location in the girder.
- Reinforced or prestressed concrete girder bearing area resulting in loss of bearing area and making girder subject to settlement.
- Reinforced concrete columns with spalling and rebar section loss causing the column to be subject to failure.
- Primary structural members with collision damage that compromises the structural capacity (including severed prestressing tendons, reinforcing steel that results in flexural cracking and negative beam camber, pier shafts, and columns).
- Concrete pier column or cap with significant structural cracking that is supporting a fracture critical bridge or fracture critical component.
- Falling concrete or concrete that is delaminated or partially detached and anticipated to fall, presenting a safety hazard to under-passing motorists and/or pedestrians.
- Bearing seats that are severely deteriorated or undermined.
- Sidewalk structural supports or walking surface with damage or deterioration presenting a hazardous condition to pedestrians.
- Substructure units with severe scour and undermining of the substructure foundation causing instability.

<u>The following deficiencies represent examples of critical findings for steel:</u>

- Steel members with deteriorated areas that have failed in buckling, crippling, more than 10% of the connectors in a connection are missing, etc., or which makes failure likely in the near future.
- Secondary structural members (diaphragms, bracing, etc.) with extensive section loss.
- Fracture critical members subjected to impact damage including gouging or tearing, perpendicular stress cracks in either the base metal or weld metal, parallel stress cracks resulting from out-of-plane distortions or poor weld details, and severe corrosion in girder flanges, webs, in truss members, or in gusset plates.
- Primary structural members with collision damage that compromises the structural capacity (including fractures, large gouges, significant twisting/kinking of beams, and section loss to truss compression members producing member buckling or severe flexural cracking).
- Primary structural member (non-FCM member) with a completely fractured tension member due to fatigue or vehicular collision.
- Pin and hanger systems in fracture critical members with severe deterioration or severe accumulation of debris or rust packing.
- Bottom flange cover plates with cracked welds at the end of a partial length welded cover plate for a steel multi-girder or steel floorbeam.
- Substructure units with severe scour and undermining of the substructure foundation causing instability.

The following deficiencies represent examples of critical findings for traffic safety features:

- Bridge railing (bridge parapets, median barriers, or structure-mounted guardrail) with damage or deterioration that may prevent containment and/or redirection of errant vehicles traveling at the posted speed limit.
- Pedestrian railing that is missing or detached, allowing a pedestrian to fall off the structure.
- Guardrail connections to bridge railing, concrete barrier rebar, or guardrail that is detached and in close proximity or projecting into traffic with potential for impact.

The following deficiencies represent examples of critical findings for signs and lighting:

- Load posting or vertical clearance signs that are missing, damaged, improperly located, or visually obstructed including relevant advance warning signs.
- Signs, traffic signals, or strain poles presenting a safety hazard to passing motorists and/or pedestrians due to extensively damaged, split or buckled sections, or with cracked welds at either pole/base connections or member/member connections.
- Sign, traffic signal, or strain pole 4-bolt base plate connections with one or more loose nuts presenting a safety hazard to passing motorists and/or pedestrians.
- Signs with deteriorated or missing panel connectors, allowing sign to "flop" under wind loading that present a safety hazard to passing motorists and/or pedestrians.
- Lighting fixtures with split sections, buckled sections, significant section loss, and/or cracked welds at the pole/base connection that present a safety hazard to passing motorists and/or pedestrians.

The following deficiencies represent other examples of critical findings:

- Expansion joints that are deteriorated, damaged, or loose which may present a safety hazard to passing traffic.
- Rocker bearings that are critically tilted either exceeding the acceptable amount of tilt or bearing on the outer one-quarter width of the rocker.
- Excessive debris and/or sediment buildup at the hydraulic opening for scour critical bridges or other bridges with unknown foundations.

APPENDIX D

Scour Monitoring Directions

Blank Scour Monitoring Log

Example Scour Monitoring Log

Example Plan of Action (POA)

Example Channel Profile

SCOUR CRITICAL BRIDGE - Monitoring Directions/Instructions

1. Bridge Closure Plan

Scour Monitoring criteria for consideration of bridge closure:

- ***Water levels reach the closure height elevation on the attached monitoring device.***
- ***Pressure flow at the bridge (the bottom of superstructure mostly or fully submerged in water).***
- ***Water overtopping the bridge deck or approach roadway.***
- ***Any noticeable vertical tilt, settlement or horizontal movement of the superstructure or substructure.***
- ***Excessive horizontal or vertical separation at bridge deck joints.***
- ***Visible damage to the bridge deck, superstructure, or substructure caused by flood waters or floating debris.***
- ***Sinkholes, settlement or erosion in the approach roadway or loss of roadway embankment.***
- ***Heavy debris accumulation or ice jams at or on the bridge severely restricting water flow through the bridge.***
- ***Washout of rock protection near the bridge substruture that indicates severe scour of the bridge.***

2. Monitoring Directions/Instructions

SAFETY FIRST! - DO NOT ENDANGER YOURELF OR OTHERS WHILE MONITORING BRIDGES.

DO NOT ENTER EITHER FLOWING OR STANDING FLOOD WATERS WHILE MONITORING SCOUR CRITICAL BRIDGES.

GENERAL INSTRUCTIONS:

Visually examine the bridge and approach roadway each time the bridge is visited. Also look at the upstream and downstream sides of the bridge and waterway channel. Circle the appropriate response for items inspected. Leave blank if not inspected. Circle "No" for no, none, or no change in condition since beginning of flood monitoring. Circle "Yes", when appropriate, based on the descriptions below. Provide a written explanation for a "Yes" response in the "Remarks" as to what was observed or changed.

****** Should you believe that the bridge is becoming unsafe for any reason, immediately close the bridge. Immediately contact the Region Engineer, Area Engineer, or Senior Region Bridge Engineer to confirm the need to close the bridge. If it is deemed necessary to keep a bridge open for emergency vehicle passage or for emergency evacuations, then the bridge must be monitored at all times (24/7).***

****** Closed bridges may be reopened only after a post-flood bridge safety inspection has been completed by the Senior Region Bridge Engineer or their designee and only after approval by the Region Engineer.***

MONITORING PERSONNEL and TIME:

Record monitoring personnel name(s) and time of monitoring.

BRIDGE:

- Pressure Flow: Has the water level reached the bottom of the bridge beams or the bottom of the bridge deck?
- Alignment: Sight along bridge beams, railing, curb, etc., for horizontal misalignment. Check specifically at the joints in the bridge over the piers or at the abutments. If the joint is wider at one side of the bridge than at the other (difference of 1/2" or more), then movement of the bridge due to scour should be suspected.
- Settlement: Sight along bridge beams, railing, curb, paint striping, etc., for vertical misalignment. Any noticeable dip at a pier or drop at an abutment indicates settlement is occurring.
- Tilt: Check the abutments and piers for plumb. If there is any noticeable tilt side-to-side, forward, or back then mark "Y".
- Water Level: Measure from the reference to the top of the water level and channel depth with a weighted tape measure. Record measurements in the remarks section.
- Overtopping: If the bridge is overtopped indicate the bridge is overtopped and approximate depth if known in the remarks.

APPROACH ROADWAY:

- Settlement: Check approach pavement for settlement. Water piping through the approach fill can cause erosion under the approach pavement causing the pavement to settle. Does it appear that there is new settlement or are there holes in the pavement?
- Embankment Erosion: Check roadway embankment slopes, shoulders, and edge of pavement for erosion. Extend limits of inspection to cover sections of the roadway that are parallel to the stream. Does a washout exist on the roadway embankments or shoulders?
- Overtopping: If the roadway is overtopped indicate the approximate depth if known in the remarks and also note it is for the roadway section.

WATERWAY CHANNEL:

- Debris Build-up: Check the bridge waterway opening for accumulation of trees, branches, ice jams, or other debris that severely restricts the flow of water and creates strong pressure on the bridge.

PICTURES:

Take plenty of pictures that can be sent to the RE, AE, or SRBE. This will help with decisions to close the bridge and allow others to see and understand what you are seeing.

SCOUR CRITICAL BRIDGE - Monitoring Log

SAFETY FIRST! - DO NOT ENDANGER YOURELF OR OTHERS WHILE MONITORING BRIDGES .

Structure Number			**Monitoring Frequency**	hrs
Maintenance Unit		**County**	**Monitoring Device Location**	
Shop Number		**Year Built**	**Monitoring Height**	ft
Feature Carried		**MRM**	**Closure Height**	ft
Feature Crossed				
Location				
Bridge Description				
Reference Location				

Area Engineer
Region Engineer
Sr. Region Bridge Engineer

Date	Monitoring Personnel	Time	Bridge						Roadway				Channel			
			Pressure Flow		Alignment/ Tilt		Settlement		Embankment Erosion		Settlement		Debris Buildup or Ice Jams		Rip Rap Movement	
			Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Remarks:																
			Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Remarks:																
			Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Remarks:																

* Send Scour Critical Bridge Monitoring Logs to Senior Region Bridge Engineer to be filed.

SCOUR CRITICAL BRIDGE - Monitoring Log

SAFETY FIRST! - DO NOT ENDANGER YOURELF OR OTHERS WHILE MONITORING BRIDGES.

Structure Number 03-253-180
Maintenance Unit 191
Shop Number 194
Feature Carried US 14
Feature Crossed James River
Location 1.3 E of Jct US 14 & SD 37
Bridge Description 4 span steel girder bridge
Reference Location Top of Curb at Bent 2

County Beadle
Year Built 1960
MRM 346.97

Monitoring Frequency 6 hrs
Monitoring Device Location Bent 2
Monitoring Height -7.8 ft
Closure Height -6.2 ft

Area Engineer
Brad Letcher
605-350-0427

Region Engineer
Jeff Senst
605-380-8996

Sr. Region Bridge Engineer
Josh Olson
605-380-9038

Date	Monitoring Personnel	Time	Bridge						Roadway				Channel			
			Pressure Flow		Alignment/ Tilt		Settlement		Embankment Erosion		Settlement		Debris Buildup or Ice Jams		Rip Rap Movement	
4/24/19	J. Olson	1130 A	Yes	(No)	Yes	(No)	Yes	(No)	Yes	(No)	Yes	(No)	(Yes)	No	Yes	(No)

Remarks:

	WL	Depth
B2	6-6"	21.3'
B3	7-6'	30.1'
B4	8.5'	22.2'

Debris on top of B2 cap.

Huron Gauge - James River → 17.37'

4/1/19	J. Olson	1220 P	Yes	(No)	Yes	(No)	Yes	(No)	Yes	(No)	Yes	(No)	Yes	(No)	Yes	(No)

Remarks:

	WL
B2	9'-10"
B4	10'-10"

overland flooding to NW No berm scour @ A1 or A5.

Contraction scour → slow ~ 1-2 fps.

Pictures 1454 - 1464 → 2019 Flooding folder

			Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No

Remarks:

* Send Scour Critical Bridge Monitoring Logs to Senior Region Bridge Engineer to be filed.

Plan Of Action
SCOUR CRITICAL BRIDGE

BRIDGE DATA:

Structure #: 03-253-180	Waterway: James River Owner: State of SD	
Bridge Type & Length: X031 326.5 ft		
Location Description: 1.3 E Jct SD 37		
MRM: 346.97	Highway: SD 14	County: Beadle
Project # (Original construction): F-030-4(03)		Year Built: 1960
Project # (Re-construction):		Year re-constructed:
Year Scheduled for replacement (if known):		
Foundation: Abutments►Footing on Timber Pile Bent(s)►Footing on Timber Pile		
►		
Bridge Traffic: ADT = 4017	Year/ADT: 2020	7 % Trucks
Subsurface Soil Type(s): Black mucky sand over silty sand and gravel over clay-sand over sandy gravel over dense gravelly glacial clay.		

NBI CODING INFORMATION:

	CURRENT	NEXT
SDDOT Maintenance Inspection Date:	**05/19/2020**	**05/19/2022**
Underwater Inspection Date (if applicable):	**09/25/2018**	**09/25/2023**

Item 113 Scour Critical ►	**3: SC, Calc scour within or below foundations**
Item 60 Substructure ►	**5: Fair Cond, sound str. w/minor deterioration**
Item 61 Channel & Protection ►	**5: Bank protctn eroded, major embankmnt damage**
Item 71 Waterway Adequacy ►	**7: Slight chance of overtopping BR deck/approach**

Prepared by: _____ Reviewed by: _____

Nicholas Palecek	Todd Thompson
►Transportation Project Engineer, P.E.	Bridge Management Engineer
►Bridge Maintenance Section	►Bridge Maintenance Section
Office of Bridge Design	Office of Bridge Design
SD Department of Transportation	SD Department of Transportation
DATE: **02/10/2011**	DATE: **05/16/2011**
Revised 1/27/2022 by Josh Olson (Aberdeen Region) and Dave Coley (Bridge Office)	

(form updated on: 5-02-2008)

SCOUR SUSCEPTIBILITY:

Scour Evaluation Summary: There are scour countermeasures at the abutments and at bent no. 2.

Historical Observations:	**Date (if known):**
☒ Adverse stream angle with the bridge berms &/or substructure	**05/05/1998**
☐ Structure Settlement/Movement	
☐ Shallow foundation with respect to channel bed	
☐ Channel Bed Degradation	
☐ Highly erodible soil	
☐ Movement of existing riprap	
☐ Extensive berm erosion exposing the piling or footing	
☐ Loss of Road Embankment	
☐ Large debris accumulating on the pier columns	
☐ Ice Jams	
☐ Water overtopping the bridge or road	

Scour History / Description of Observations: The 2018 underwater inspection report indicates there is exposure of the Bent 3 footing.

Inspected by: ☒ SDDOT ☒ Other Collins Engineers, Inc.

RECOMMENDED ACTIONS:

	IMPLEMENTATION DATE
☐ Increased Inspection Frequency (routine NBIS)	
☐ Increased Inspection Frequency (underwater inspection)	
☐ Flood Monitoring Device(s)	
☐ Fixed Monitoring Program	
☒ Hydraulic/Structural Countermeasures	

MONITORING PROGRAM:

Monitoring Plan Summary: Should monitor the bridge during flood events and close the bridgewhen flows exceed Q100 or when water reaches the top of the bent caps.

☒ Regular Inspection Program ☒ w/surveyed cross sections
Items to watch: Scour around abutments
☐ Increased Inspection Frequency of months ☐ w/surveyed cross sections
Items to watch:
☒ Underwater Inspection Required
Items to watch: Scour around bents 3 and 4
☐ Increased Underwater Inspection Frequency of months
Items to watch:

☒ **Flood Monitoring Program**

Type:► Visual Inspection
Flood monitoring required: ☒ Yes ☐ No
Flood monitoring event defined by (*check all that apply*):
☒ Discharge 18,100 cfs ± ☒ Stage 1240.5' ± (middle of bent cap at bent no. 2) or -7.8’ below the top of the north curb at Bent 2.
☐ Elev. measured from ☐ Rainfall: in / hr
☐ Flood forecasting information:
☐ Flood warning system:
Frequency of flood monitoring:► 6 hr.
Criteria for termination of flood monitoring: Water drops below the top of the bent cap and no scour is noted.
Scour critical elevation(s) for each pier/abutment: 5 to 6 feet of exposed pile.

Action(s) required if scour critical elevation detected (include notification and closure procedures):Close bridge, set up barriers and traffic control for detour route, and send out public notification.

☒ **Fixed Monitoring Device(s)**

Type of Instrument: Galvanized chains attached to the backside of the north barrier.
Installation location(s): Bent 2
Sample Interval:► N/A
Frequency of data downloads and reviews:► N/A
Scour alert elevation(s) for each pier/abutment:
Scour critical elevation(s) for each pier/abutment: Abutment 1 @ -13.9' below top of north curb. Bent 2 @ -31.0' below top of north curb. Bent 3 @ -35.2' below top of north curb. Bent 4 @ -32.7' below top of north curb. Abutment 5 @ -13.9' below top of north curb.
Survey ties:
Criteria of termination for fixed monitoring:

Agency and Department responsible for monitoring: Huron Area Office of SDDOT

Contact Person: Huron Area Engineer, 605-353-7140

COUNTERMEASURE RECOMMENDATIONS:

Prioritize alternatives below. Include information on any hydraulic, structural or monitoring countermeasures.
2015 scour countermeasure project was canceled. Structure will be replaced with PCN 07DF when condition dictates.

Countermeasures implementation project type:► Bridge Maintenance Project

Target design completion date: **N/A**
Target construction completion date:
Countermeasures already completed: Riprap on the berm at abutment 1 and around bent 2.

BRIDGE CLOSURE PLAN:

Scour monitoring criteria for consideration of bridge closure:

- ☒ Water surface elevation reaches 1242.10 (6.2' below the top of the north curb at Bent 2) at bridge. Datum used:► NGVD29
- ☐ Relative Measure (e.g. paint mark on bridge column)
- ☐ Overtopping road or structure
- ☐ Scour measurement results / Monitoring device (See Section).
- ☐ Observed structure movement / Settlement
- ☒ Discharge: cfs
- ☐ Flood forecast:
- ☐ Debris accumulation
- ☐ Movement of erosion protection
- ☐ Loss of road embankment

Criteria for re-opening the bridge:
Water drops below elevation 1240.5', no scour is noted, and erosion protection is still in place.

The ► Aberdeen Region Engineer of SDDOT or his/her designee is responsible for closing and re-opening this bridge due to scour critical conditions. Consult with the SDDOT Bridge Office when the bridge is closed.

Contact Person: Aberdeen Region Engineer, 605-626-2244

DETOUR ROUTE:

The ► Aberdeen Region Engineer of SDDOT or his/her designee is responsible for determining the location and equipment used for the detour route(s).

Detour route description (route number, from/to, distance from bridge, etc.), including detour map. See attachmentB.

Bridges on Detour Route:

Hwy.	MRM	Bridge Structure No.	Waterway	Sufficiency Rating/ Load Limitations	Item 113 Code:
		- -			►
		- -			►
		- -			►
		- -			►

Traffic control equipment (detour signing and barriers) and location(s):

Additional considerations or critical issues (susceptibility to overtopping, limited waterway adequacy, lane restrictions, etc.):

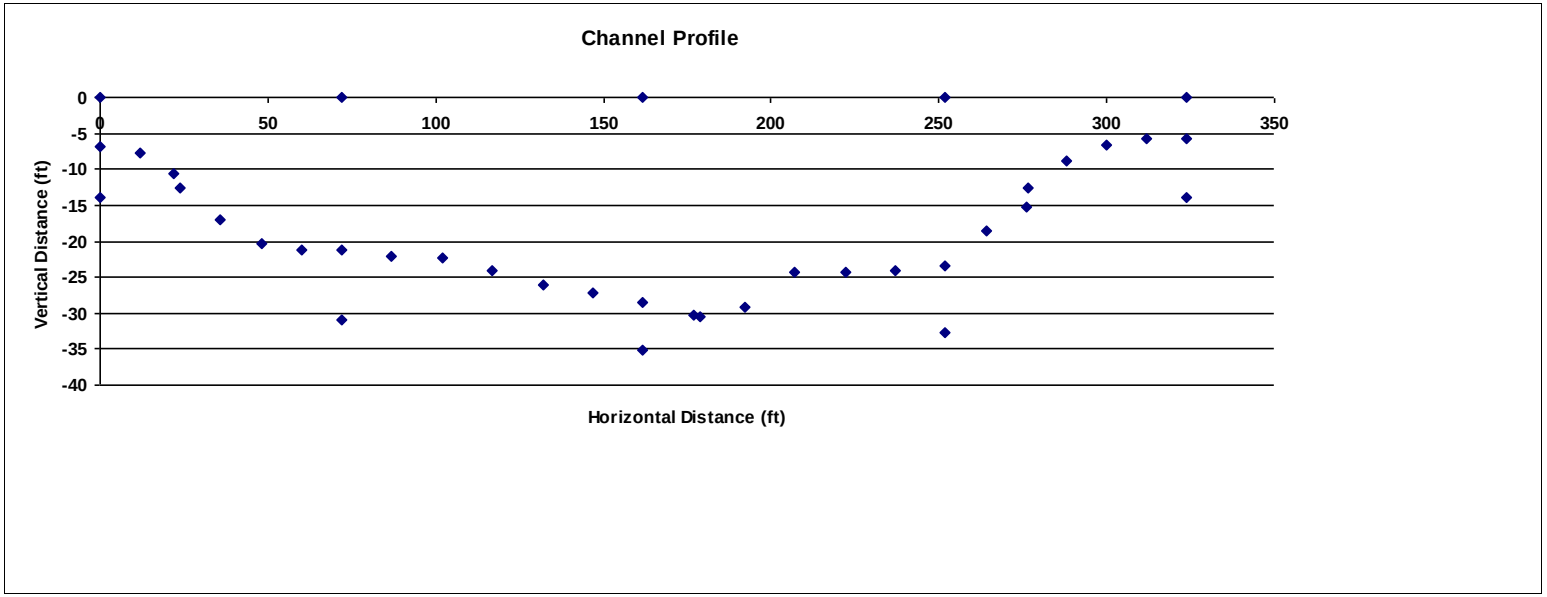
☒ Public Notification from Region Office

ATTACHMENTS:

☒ Attachment A: Bridge elevation showing existing streambed, foundation depth(s) and observed and/or calculated scour depths

☐ Attachment B: Map showing detour route(s)

Reference: top of north curb, upstream side (front of NE wing)



Date Profile Taken: 5/19/2020

Profile Taken By: Q. Berger and J. Heidenreich

Reason: NBI Inspection

Point	Horz	Vert
Abut 1	0.0	0.0
1-0 Channel	0.0	-6.8
Abut 1 SCE	0.0	-13.9
1-1 Channel	12.0	-7.8
Shore 1	22.0	-10.6
1-2 Channel	24.0	-12.5
1-3 Channel	36.0	-17.0
1-4 Channel	48.0	-20.4
1-5 Channel	60.0	-21.2
Bent 2	71.8	0.0
2-0 Channel	71.8	-21.2
Bent 2 SCE	71.8	-31.0
2-1 Channel	87.0	-22.2
2-2 Channel	102.0	-22.3
2-3 Channel	117.0	-24.1
2-4 Channel	132.0	-26.0
2-5 Channel	147.0	-27.1
Bent 3	161.8	0.0
3-0 Channel	161.8	-28.5
Bent 3 SCE	161.8	-35.2
3-1 Channel	177.0	-30.3
Deep	179.0	-30.4
3-2 Channel	192.0	-29.2
3-3 Channel	207.0	-24.2
3-4 Channel	222.0	-24.2
3-5 Channel	237.0	-24.0
Bent 4	251.8	0.0
4-0 Channel	251.8	-23.4
Bent 4 SCE	251.8	-32.7
4-1 Channel	264.0	-18.6
4-2 Channel	276.0	-15.3
Shore 2	276.5	-12.7
4-3 Channel	288.0	-8.8
4-4 Channel	300.0	-6.7
4-5 Channel	312.0	-5.8
Abut 5	323.7	0.0
5-0 Channel	323.7	-5.7
Abut 5 SCE	323.7	-13.9

APPENDIX E

Inspection Interval

Department of Transportation

Division of Operations

700 East Broadway Avenue
Pierre, SD 57501-2586 605/773-3571
FAX: 605/773-2893

MEMORANDUM

To: All DOT Staff

From: Greg Fuller, Director of Operations

Date: December 29, 2016

RE: Procedure for notification of damage to bridges due to vehicle impacts

1. **Any staff member** who receives notification of or observes an over-height vehicle impacting a bridge superstructure, a vehicle impacting a bridge substructure, or other significant event that has the potential to affect the structural integrity of a bridge should immediately notify (in the following order) one of the **Appropriate Supervisory Personnel** as follows:

    1. Highway Maintenance Supervisor
    2. Lead Highway Maintenance Worker
    3. Area Engineer
    4. Engineering Supervisor

    Do not rely on email. Positive notification must be verified.

    Initial notification of vehicle damage to a bridge can come from many different sources:

        a. General Public
        b. Highway Patrol
        c. Local Law Enforcement
        d. Staff

    Notification must be made regardless of the extent of damage.

2. The **Highway Maintenance Supervisor, Lead Highway Maintenance Worker, or other Appropriate Supervisory Personnel** will as soon as possible:

        a. Document the party responsible for the damage and/or report to 911.

b. Coordinate with law enforcement regarding traffic control, debris cleanup, etc.
c. Update IRIS regarding any impacts to traffic.

3. The **Highway Maintenance Supervisor, Lead Highway Maintenance Worker, or other Appropriate Supervisory Personnel** shall make positive notification as soon as possible to:
   - Area Engineer or Engineering Supervisor (if not previously contacted in Step 1).
   - Senior Region Bridge Engineer or Region Bridge Engineer

   If known, the notification should include information regarding;
   - Location of the Bridge
   - Extent of the damage and the location of the damage on the bridge (please include pictures if at all possible.)
   - Type of Bridge: Steel Girder, Prestressed Concrete Girder, Continuous Concrete Slab
   - Is bridge temporarily closed or otherwise restricted to travel
   - How is traffic being handled

4. The **Highway Maintenance Supervisor, Lead Highway Maintenance Worker, or other Appropriate Supervisory Personnel** (or their designee) should make prompt **email** contact to:
   - Region Engineer
   - Area Engineer
   - Office of Bridge Design
     - Chief Bridge Engineer – Steve Johnson
     - Bridge Maintenance Engineer – Todd Thompson
     - Bridge Management Engineer – Dave Coley
   - Director of Operations – Greg Fuller
   - Director of Planning and Engineering – Mike Behm
   - Kristi Sandal – PIO (The Area Office will make any initial contact with local media as required and coordinate with Kristi on any further communication as necessary.)
   - Joanie Blair, Finance and Management
   - Area Office Secretary

5. The **Office of Bridge Design** will make notification to:
   - FHWA
   - Tom Newell, Operations Support (for any clearance or weight restrictions)
   - Mark King, Operations Support (will set up PCN for maintenance repair project if necessary).

6. The **Senior Region Bridge Engineer or Region Bridge Engineer** will provide an update via email to those contacts identified in Step 4 once they have had a chance to inspect the structure.

APPENDIX E

Inspection Interval Criteria and Protocol

The following document details the inspection interval criteria provided to FHWA.

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION CRITERIA FOR TYPES OF BRIDGE INSPECTIONS FOR STATE AND LOCAL BRIDGES

GENERAL

Bridge inspections are conducted to determine the physical and functional condition of the bridge; to form the basis for the evaluation and load rating of the bridge, as well as analysis of overload permit applications; to initiate maintenance actions; to provide a continuous record of bridge condition and rate of deterioration; and to establish priorities for repair and rehabilitation programs. Individuals responsible for bridge inspection, load rating, permits, and maintenance are essential to the overall effectiveness of bridge inspection and maintenance programs.

Successful bridge inspection is dependent on proper planning and techniques, adequate equipment, and the experience and reliability of the personnel performing the inspection. Inspections should not be confined to searching for defects which may exist but should include anticipating problems. Thus, inspections are performed to develop both preventive as well as corrective maintenance programs. The inspection plan and techniques should ensure that:

- Unique structural characteristics and potential issues of individual bridges are considered in developing an inspection plan.
- Current technology and practice are applied during the inspection.
- The intensity and interval of inspection is consistent with the type of structure, details, and the potential for failure.
- Inspection personnel are assigned in accordance with their qualifications.

There are eight types of bridge inspections: Initial, Routine, Damage, In-depth, Special, Scour, Nonredundant Steel Tension Member, and Underwater Inspections. The scope and interval of the various types of bridge safety inspections are described here to provide an understanding of the purpose and use of each inspection type. These inspections are performed at intervals that are influenced by the individual bridges structural condition, structure type and details, site conditions, load capacity evaluation, and scour critical evaluation.

The scope and frequencies for Ancillary structure inspections are also covered in this document.

INITIAL INSPECTIONS

As defined by NBIS 23 CFR § 650.305:

> *Initial inspection.* The first inspection of a new, replaced, or rehabilitated bridge. This inspection serves to record required bridge inventory data, established baseline conditions, and establish the intervals for other inspection types.

Scope of Initial Inspections

The initial inspection serves to provide verification of inventory information that has been entered into BrM by the bridge inspector and to document its structural and functional conditions by:

- Verification that required SI&A data in BrM is accurate per Federal regulations along with all other data required by SDDOT standards
- Determining baseline structural conditions
- Determining if the bridge will require a channel cross-section and/or be added to the underwater inspection list
- Identifying and listing any existing problems
- Identifying maintenance needs, including preventative maintenance activities

Coinciding with the initial inspection is the creation of the bridge file for the structure. Documents including, but not limited to, plans, SI&A sheets, photographs, bridge load ratings and signing recommendations, scour analysis, and foundation information are to be included in the bridge file. Selected construction records (e.g., pile driving records, field changes) may also be of great use in the future and should be included. Maintenance records for existing and temporary bridges should also be included.

The level of effort required to perform an initial inspection will vary per the structure's type, size, complexity, and location. An initial inspection needs to verify that all inspection elements have been accounted for and document the baseline conditions. Traffic control and special access equipment may be required. If the bridge subjected to an initial inspection is anything other than a newly constructed structure, it may be necessary to include some or all the elements of an in-depth inspection within 3 months of opening to traffic.

Intervals for Initial Inspections

As stated in section 4.2.4.1 of the Manual for Bridge Evaluation (MBE), initial inspections are not recurrent and thus do not have an established inspection interval. However, upon completion of new bridge construction, rehabilitation, or installation of temporary bridge, and once the bridge is open to traffic, the initial bridge inspection must be completed within months. Once the field inspection is completed, the inventory must be updated within 3 months. Once the initial inspection is entered in BrM and approved by the Bridge Management Engineer for State owned bridges and Local Government Bridge Inspection Engineer for Local owned bridges, most new bridges will be assigned a routine inspection interval of 12, 24 or 48 months based on the routine inspection interval criteria. It is contingent on the Area Office or Local Government to notify the

Bridge Design, Region Bridge and LGA offices, as appropriate, when any part of the bridge is open to traffic.

Initial inspections for State and Local bridges let by SDDOT shall be completed by the respective region bridge inspection team once construction, rehabilitation or widening projects have been completed.

ROUTINE INSPECTIONS

As defined by NBIS 23 CFR § 650.305:

> *Routine inspection.* Regularly scheduled comprehensive inspection consisting of observations and measurements needed to determine the physical and functional condition of the bridge and identify changes from previously recorded conditions.

Scope of Routine Inspections

Routine inspections are also known as "regular" and "NBIS" inspections. Although these inspections are used to determine bridge maintenance or repair needs, the primary focus of the routine inspection is public safety. This inspection includes sufficient observations and measurements to determine the physical condition of a structure to accomplish the following functions:

- Determine the physical and functional condition of the structure and its components
- Identify changes from the previously recorded conditions
- Correct any inaccuracies in bridge inventory data noted during the inspection
- Determine the need for the load-carrying capacity to be re-evaluated based on either the condition of the structural members or increased dead loading
- Identify and document potential problems that may affect bridge safety
- Determine maintenance needs that may be required.
- Report critical findings found during inspection.

The level of detail and effort required to perform a routine inspection will vary per the structure's type, size, design complexity, existing conditions, and location. Generally, every element in a bridge does not require a hands-on inspection during each routine inspection to provide an acceptable level of safety. Knowledge of the structure and good engineering judgment are necessary when considering those portions that do not require a hands-on inspection during each routine inspection.

Bridge elements requiring extra attention during each routine inspection include, but are not limited to:

- Load carrying members in Poor condition
- Redundancy retrofit systems (e.g., Catcher-beams) for nonredundant steel tension member details (pin
  hangers, etc.)
- Critical sections of controlling members on load posted bridges
- End regions of steel girders or beams in Poor condition under a deck joint

- Cantilever portions of concrete piers or bents in Fair condition or less
- Timber substructure elements in Poor condition.
- Other areas determined by the Program Manager or Team Leader to be potentially critical

The application of the guidelines noted above does not relieve the Team Leader from the responsibility to perform other hands-on inspection tasks and/or tests needed to ascertain the condition of the bridge and assure its safety. If the Team Leader feels additional access equipment, special tools or specific testing equipment is required, this should be discussed with the Program Manager.

Routine inspections are generally conducted from the deck, ground and/or water level, ladders, lifts, and from permanent work platforms or walkways, if present. Inspection of underwater members of the substructure is generally limited to observations during periods of low flow (4 ft. or less) by probing/sounding for evidence of local scour and by wading.

Special attention should be given to the wearing surface type and thickness during each routine inspection. If there appears to be a recent overlay on the structure that has occurred since the previous inspection, it is possible the inventory data hasn't been updated. Additional dead loads resulting from increased thickness or bridge rails have a direct impact on the load carrying capacity of the structure. Refer to the Load Rating Manual for additional information and general guidelines for when a bridge load re-rating may be warranted.

A general review of inventory items should be a part of each routine inspection, with any needed corrections noted along with other inspection findings. The goal is to have the bridge inventory data as accurate as possible, and this can only be accomplished by a periodic review of this data. This general review of inventory information during the routine inspection does not necessarily require the inspector to take physical measurements but should include an effort to identify obvious errors in existing structure inventory information.

The results of a routine inspection should be fully documented with appropriate photographs and a written report that includes any recommendations for maintenance or repair and for scheduling of follow-up in-depth or special inspections, if necessary. On local bridges re-evaluate the load capacity when changes in structural conditions would affect any previously recorded ratings. When changes in structural conditions may affect ratings on state bridges contact the Office of Bridge Design.

Intervals for Routine Inspections

Regular Intervals. Each bridge must be inspected at regular intervals not to exceed 24 months, except as required by reduced interval or allowed by extended interval requirements.

Reduced Intervals. Certain bridges meeting any of the following criteria as recorded in the National Bridge Inventory (NBI) must be inspected at intervals not to exceed 12 months (NBIS 23 CFR § 650.311 Method 1):

- One or more of the deck, superstructure, substructure, or culvert components is rated in serious or worse condition, as recorded by the Deck (B.C.01), Superstructures (B.C.02), Substructure (B.C.03), or Culvert Condition Rating item (B.C.04), coded three (3) or less; or
- The observed scour condition is rated serious or worse, as recorded by the Scour Condition Rating item coded (3) or less (B.C.11).

Where condition ratings are coded three (3) or less due to localized deficiencies, a special inspection limited to those deficiencies described in NBIS 23 CFR § 650.313 can be used to meet this requirement in lieu of routine inspection. In such cases, a complete routine inspection must be conducted at regular intervals not to exceed 24 months.

Extended Intervals. Certain bridges meeting all of the following criteria as recorded in the NBI may be inspected at intervals not to exceed 48 months (NBIS 23 CFR § 650.311):

- The deck, superstructure, substructure, and culvert, components are all rated in satisfactory or better condition, as recorded by the Deck Superstructure, Substructure, or Culvert Condition Rating items coded six (6) or greater (B.C.01, B.C.02, B.C.03, B.C.04);
- The channel and channel protection are rated in satisfactory or better condition, as recorded by the Channel Condition (B.C.09) and Channel Protection Condition (B.C.10) items coded six (6) or greater;
- The inventory rating is greater than or equal to the standard AASHTO HS-20 or HL-93 loading and routine permit loads are not restricted or not carried/issued, as recorded by the Inventory Load Rating Factor item (B.LR.05) coded greater than or equal to 1.0 and the Routine Permit Loads item (B.LR.08) coded A or N;
- A steel bridge does not have Category E or E' fatigue details as recorded by the Fatigue Details (B.IR.02) item coded N;
- All roadway vertical clearances are greater than or equal to 14'- 0", as recorded in the Highway Minimum Vertical Clearance item (B.H.13);
- All superstructure materials limited to concrete and steel and all superstructure types limited to certain arches, box girders/beams, frames, girders/beams, slabs, and culverts, as recorded by:
    - Span Material items (B.SP.04) coded:
        - C01 (reinforced concrete)
        - C02 (reinforced concrete – precast)
        - C03 (prestressed concrete – pre-tensioned)
        - C04 (prestressed concrete – cast-in-place post-tensioned)
        - C05 (prestressed concrete – precast post-tensioned)
        - S01 (steel – rolled shapes)
        - S02 (steel – welded shapes)
        - S03 (steel – bolted shapes)
        - S04 (steel – riveted shapes)
        - S05 (steel – bolted and riveted shapes),

  - and Span Type items (B.SP.06) coded:
    - A01 (arch – under fill without spandrel)
    - B02 (box girder/beam – multiple adjacent)
    - B03 (box girder/beam – multiple spread)
    - F01 (frame – three sided)
    - F02 (frame – four sided)
    - G01 (girder/beam – I-shaped adjacent)
    - G02 (girder/beam – I-shaped spread)
    - G03 (girder/beam – tee-beam)
    - G04 (girder/beam – inverted tee-beam)
    - G05 (girder/beam – double-tee adjacent)
    - G06 (girder/beam – double-tee spread)
    - G07 (girder/beam – channel adjacent)
    - G08 (girder/beam – channel spread)
    - P01 (pipe – rigid)
    - P02 (pipe – flexible).
    - S01 (slab – solid)
    - S02 (slab – voided)
- Stable for potential scour and observed scour condition is rated satisfactory or better, as recorded by the Scour Vulnerability item (B.AP.03) coded A or B and the Scour Condition Rating item (B.C.11) coded six (6) or greater.
- Structure is not a concrete umbrella bridge (requirement set by SDDOT).
- Structure does not contain primary steel members that have field welded butt splices (requirement set by SDDOT).

Pedestrian Overpass Inspections

All overpass bridges with adequate vertical clearance which do not carry motor vehicle traffic (pedestrian bridges) shall be inspected at a 60-month inspection interval. Only the under records for these bridges need to be submitted to Federal Highway Association (FHWA).

DAMAGE, IN-DEPTH, AND SPECIAL INSPECTIONS

As defined by NBIS 23 CFR § 650.305:

> *Damage Inspection.* This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.
>
> *In-depth Inspection.* A close-up, detailed inspection of one or more bridge members located above or below water, using visual or nondestructive evaluation techniques as

required to identify any deficiencies not readily detectable using routine inspection procedures. Hands-on inspection may be necessary at some locations. In-depth inspections may occur more or less frequently than routine inspections, as outlined in bridge specific inspection procedures.

Special Inspection. An inspection scheduled at the discretion of the bridge owner, used to monitor a particular known or suspected deficiency, or to monitor special details or unusual characteristics of a bridge that does not necessarily have defects.

Scope of Damage Inspections

Damage inspections are performed to investigate damage and to evaluate the potential effect on the load-carrying capacity of the structure. A damage inspection may also be used to determine the immediate need to place an emergency restriction on a bridge due to a traffic impact or extreme weather event, or to determine repairs that are necessary to put the bridge back into service.

The scope of the damage inspection must match the level of detail necessary to determine the safe load-carrying capacity of the structure accurately and adequately. Inspectors must evaluate any fractured members, determine extent of section loss, take measurements for misalignment of members, and check for any loss of foundation support. In the case of an assessment due to a severe weather event or bridge impact, the inspector may need to make an on-site determination of the need to close or severely restrict the traffic on the structure. The capability to make on-site calculations to establish emergency load restrictions may be desirable. This inspection may be supplemented by a timely In-Depth Inspection as described below to document verification of field measurements and calculations and perhaps a more refined analysis to establish or adjust interim load restrictions or required follow-up procedures. Refer to the Load Rating Manual for additional information on conducting inspections for completing a bridge load re-rating for structures with damaged members. An awareness of the potential for litigation must be recognized in the documentation of Damage Inspections.

If a damage inspection produces a critical finding, the South Dakota Department of Transportation Critical Findings document must be completed and submitted in a timely manner and FHWA must be notified within 24 hours. A critical finding, at a minimum, includes the following (NBIS 23 CFR § 650.313):

- Full or partial closure of any bridge;
- An NSTM to be rated in serious or worse condition, as defined in the NBI by the NSTM inspection item (B.C.14), coded three (3) or less;
- A deck , superstructure, substructure, or culvert component to be rated in critical or worse condition, as defined in the NBI by the Deck, Superstructure, or Substructure Condition Rating items, or Culvert Condition Rating item, coded two (2) or less (B.C.01, B.C.02, B.C.03, B.C.04);
- The channel condition or scour condition to be rated in critical or worse condition as defined in the NBI by the Channel Condition Rating (B.C.09) or Scour Condition Rating (B.C.11) items, coded two (2) or less; or

- Immediate load restriction or posting, or immediate repair work to a bridge, including shoring, in order to remain open.

Interval of Damage Inspections

Damage inspections are performed on an as-needed basis as determined by the Bridge Owner.

Scope of In-Depth Inspections

In-depth inspections serve to collect and document the existing condition of all elements in greater detail than a typical routine inspection. These inspections can also provide the necessary documentation of deficiencies for use in determining the need for immediate repairs or future rehabilitation of the structure. Many times, this data is more difficult to collect than data collected during a routine inspection.

The level of effort required to perform an in-depth inspection will vary per the structure's type, size, design complexity, existing conditions, and location. Traffic control and special equipment, such as an under-bridge inspection equipment, bucket truck, man lift or specialized rigging may be required to adequately perform an in-depth inspection. Inspectors with special skills such as divers, riggers and certified non-destructive testing technicians may also be required. Other non-destructive and/or material tests can be part of an in-depth inspection to determine the extent of a finding or evaluate the existing strength of a bridge element. A structural analysis for load carrying capacity may be required with an in-depth inspection to fully evaluate the findings of this more detailed inspection of the member or members, depending on the extent of the deterioration or damage. Nondestructive load tests may be conducted to assist in determining a safe bridge load-carrying capacity.

On small bridges, the in-depth inspection, if warranted, should include all critical elements of the structure. For large and complex structures, these inspections may be scheduled separately for defined segments of the bridge or for designated groups of elements, connections, or details that can be efficiently addressed by the same or similar inspection techniques. If the latter option is used, each defined bridge segment, each designated group of elements, or both; connections; or details should be clearly identified as a matter of record, and each should be assigned a interval for reinspection. To an even greater extent than is necessary for initial and routine inspections, the activities, procedures, and findings of in-depth inspections should be completely and carefully documented.

Interval of In-Depth Inspections

The interval of an in-depth inspection will be established by the Bridge Owner. An in-depth inspection that includes all elements and satisfies all requirements of a routine inspection can be scheduled to take the place of a routine inspection for a given inspection cycle. This type of inspection can also be scheduled independently of a routine inspection, though generally at a longer interval. In-depth inspections may also be scheduled as a follow-up inspection to damage or initial inspections.

For large bridge structures, in-depth inspections should be routinely scheduled to ensure that maintenance work is identified early, programmed to secure funding, and completed in a timely manner.

Scope of Special Inspections

Special inspections are performed in addition to the other NBIS inspections and typically focus on specific elements of the structure. They may be prompted by structural deterioration, conditions affecting the stability of the structure, or for other reasons at the discretion of the Program Manager or LGA Bridge Inspection Engineer. Some examples of Special Inspections would be:

- Extensive deterioration to main load carrying members
- Recorded or potential scour
- Movement of a substructure unit
- Settlement
- Damage or Impact
- A pinned assembly requiring non-destructive testing on a set routine inspection interval
- Structural details with a history of poor performance such as pin and hanger details

Special inspections that require ultrasonic testing (UT) of pins are conducted by contract. These inspections may be completed in conjunction with both Region and Local Agency inspectors. Only qualified American Society for Non-Destructive Testing Level II or III technicians shall provide ultrasonic NDT services.

The Bridge Office will maintain a list of those state bridges which contain unique or special features requiring additional attention to ensure the safety of such bridges (e.g. pin and hanger details and steel pier caps). Inspections will be conducted following appropriate SDDOT safety guidelines for both the employee and the public.

Interval of Special Inspections

Any bridge where issues have been found that affect only a portion of the structure shall receive Special Inspections on an interval more often than the Routine Inspection. All bridges requiring Special Inspections shall be identified relative to the location(s) of the feature(s) that need to be inspected and the interval at which they are inspected. For example, all "Umbrella" continuous concrete bridges are to receive special inspections due to the issue with deck cracking at the interface between voided slab and regular concrete sections.

Pin and hanger details and pinned assemblies shall receive a special inspection at an interval not to exceed 60 months. Other special inspections may be established at the discretion of the Program Manager or LGA Bridge Inspection Engineer. Reduction in inspection interval (e.g. 24 months to 12 months) may be determined by the Program Manager or LGA Bridge Inspection Engineer based on inspection findings if deemed necessary.

Special Inspections may be regularly scheduled until repairs are made, corrective actions are taken to reduce or negate any potential risks to the safety of the structure, or the poor performing structural details are removed from the structure.

NONREDUNDANT STEEL TENSION MEMBER INSPECTIONS

As defined by NBIS 23 CFR § 650.305:

> *Nonredundant Steel Tension Member (NSTM).* A primary steel member fully or partially in tension, and without load path redundancy, system redundancy or internal redundancy, whose failure may cause a portion of or the entire bridge to collapse.
>
> *Nonredundant Steel Tension Member inspection.* A hands-on inspection of a nonredundant steel tension member.
>
> *Hands-on Inspection.* Inspection within arm's length of the member. Inspection uses visual techniques that may be supplemented by nondestructive evaluation techniques.

Scope of Nonredundant Steel Tension Member Inspections

Inspection under these guidelines will apply to all bridges that have at least one member determined to be a nonredundant steel tension member (NSTM) except those bridges that carry only railroad and or pedestrian traffic. The Office of Bridge Design will evaluate state owned bridges that are not load path redundant to determine if and where NSTMs are present. NSTM inspections shall be conducted using an under-bridge inspection vehicle, bucket trucks, man lifts, rigging, boats, ladders or any means necessary to visually inspect all NSTMs hands-on. Inspections will be conducted following appropriate SDDOT safety guidelines for both the employee and the public. The first NSTM inspection for each bridge (new or rehabilitated) is required within 12 months of the bridge opening to traffic.

The Office of Bridge Design and LGA Office will maintain a list and an inspection plan for those bridges which contain NSTMs to ensure the safety of such bridges. Files will contain the following items for the NSTM inspection plan (NBIS 23 CFR § 650.313):

- Location and description of NSTMs
- Inspection interval
- Inspection procedure(s)

Intervals of Nonredundant Steel Tension Member Inspections

Regular Intervals. Each NSTM must be inspected at intervals not to exceed 24 months except as required by reduced intervals or extended intervals.

Reduced Intervals. State transportation departments, federal agencies, or tribal governments must determine when intervals must be reduced below 24 months (NBIS 23 CFR § 650.311 Method 1).

- Factors to consider include structure type, design, materials, age, condition, environment, annual average daily traffic and annual daily truck traffic, history of vehicle impact damage, loads and safe load capacity, and other known deficiencies.
- NSTMs that are rated in poor or worse condition, as recorded by the NSTM Inspection Condition item (B.C.14), coded 4 or less must be inspected at intervals not to exceed 12 months.

Extended Intervals. Certain NSTMs meeting all the following criteria may be inspected at intervals not to exceed 48 months (NBIS 23 CFR § 650.311 Method 1):

- Bridge was constructed after 1978 as recorded in NBI Year Built item and fabricated in accordance with a fracture control plan;
- All NSTMs have no fatigue details with finite life;
- All NSTMs have no history of fatigue cracks;
- All NSTMs are rated in satisfactory or better condition, as recorded in the NBI by the NSTM Inspection Condition (B.C.14) item, coded 6 or greater; and
- The bridge's inventory rating is greater than or equal to the standard HS-20 or HL-93 loading and routine permit loads are not restricted or not carried/issued, as recorded in NBI (see § 650.315) by the Inventory Load Rating Factor (B.LR.05) item coded greater than or equal to 1 and Routine Permit Loads (B.LR.08) item coded A or N;
- All NSTMs do not include pin and hanger assemblies.

UNDERWATER INSPECTIONS

As defined by NBIS 23 CFR § 650.305:

> *Underwater Inspection.* Inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water by wading or probing, generally requiring diving or other appropriate techniques.

Scope of Underwater Inspections

NBIS requires inspection of all bridges to determine the condition of the underwater portion of the substructures with certainty. FHWA defines a bridge as needing an underwater inspection when, "the underwater portion of a bridge substructure and the surrounding channel cannot be inspected visually at low water or by wading or probing, and generally requiring diving or other appropriate techniques". SDDOT requires that a structure requires an underwater inspection when FHWA underwater inspection definition is met, or the water is greater than 3 feet. It can also apply to structures that cannot be examined by feel for condition, integrity, and safe load capacity due to excessive water velocity and/or turbidity.

The first underwater inspection for new and rehabilitated structures is required to take place within 12 months of opening to traffic. Underwater inspections shall be both a visual and a tactile inspection of the entire underwater portion of the substructure. Inspections shall include checking all concrete for erosion, wear, and abrasion, scaling, spalling, exposure, and deterioration, and for any exposed reinforcing steel and all cracking. All exposed structural steel and piling shall be checked for misalignment and loss of section. All timber shall be sounded and checked for presence of bores, decay, weathering. The channel bottom shall also be inspected for presence, size, condition of riprap, and for any evidence of scour. Underwater inspections should be conducted in a systematic and organized manner that will be efficient and minimize the possibility of any underwater bridge item being overlooked.

The Operations Support Office will administer the underwater inspections consultant contract process for all bridges requiring underwater inspections. The SDDOT will maintain a list of the following for those bridges which require Underwater Inspections:

- Location of the bridge and member to be inspected.
- Type of foundation
- Bottom of foundation elevation or pile tip elevation
- Depth soundings at bridge as well as upstream and downstream of bridge
- Type and frequency of required inspections
- Inspection procedure(s)
- Date of last inspection
- Special equipment requirements
- Description of inspection findings
- Description of any follow-up action(s) resulting from most recent inspection

Underwater inspections must be conducted under the direct supervision of a certified Team Leader. Qualifications for inspection personal can be found in the SDDOT NBIS Safety Bridge Inspection Policy (DOT-P&E-BR-2.4).

Interval of Underwater Inspections

Regular Intervals. Each bridge must be inspected at regular intervals not to exceed 60 months, except as required by reduced intervals or allowed by extended intervals.

Reduced Intervals. Certain bridges meeting any of the following criteria as recorded in the NBI must be inspected at intervals not to exceed 24 months (NBIS 23 CFR § 650.311 Method 1):

- The underwater portions of the bridge are in serious or worse condition, as recorded by the Underwater Inspection Condition item (B.C.15) coded three (3) or less.
- The channel or channel protection is in serious or worse condition, as recorded by the Channel Condition (B.C.09) and Channel Protection Condition (B.C.10) items coded three (3) or less.
- The observed scour condition is three (3) or less, as recorded by the Scour Condition Rating item (B.C.11).

Where condition ratings are coded three (3) or less due to localized deficiencies, a special inspection of the underwater portions of the bridge limited to those deficiencies, can be used to meet this requirement in lieu of complete underwater inspection.

Extended Intervals. Certain bridges meeting all of the following criteria as recorded in the NBI may be inspected at intervals not to exceed 60 months (NBIS 23 CFR § 650.311 Method 1):

- The underwater portions of the bridge are in satisfactory or better condition, as recorded by the Underwater Inspection Condition (B.C.15) item coded six (6) or greater;
- The channel and channel protection are in satisfactory or better condition, as indicated by the Channel Condition (B.C.09) and Channel Protection Condition (B.C.10) items coded six (6) or greater;
- Stable for potential scour, Scour Vulnerability (B.AP.03) coded A or B, and Scour Condition Rating item (B.C.11) is satisfactory or better, coded six (6) or greater.

Underwater inspections by a certified engineer-diver may also be required for a scour critical bridge immediately after flood events.

SCOUR INSPECTIONS

Scour critical bridges shall be monitored during and inspected after periods of scour critical flows. Specific time interval scour inspections will not be required due to a structure being classified as scour critical. Local Government System structures are included in these criteria.

Scour Inspection Procedures

First, perform a scour appraisal for all bridges over water and document the process and results in the bridge file. Re-appraise when necessary to reflect changing scour conditions. Scour appraisal procedures should be consistent with Hydraulic Engineering Circulars (HEC) 18 and 20. Guidance for scour evaluations in located in HEC 20.

Second, for bridges which are determined to be scour critical or have unknown foundations, prepare, and document a scour plan of action (POA) for deployment of scour countermeasures for known and potential deficiencies, and to address safety concerns. The plan must address a schedule for repairing or installing physical and/or hydraulic scour countermeasures, and/or the use of monitoring as a scour countermeasure. Scour plans of actions should be consistent with HEC 18 and 23. Finally, execute action in accordance with the plan.

ANCILLARY STRUCTURE INSPECTIONS

Reference Publication FHWA NHI 05-036 Guidelines for the Installation, Inspection, Maintenance and Repair of Structural Supports for Highway Signs, Luminaires and Traffic Signals.

Interval for Ancillary Inspections

High Mast Light Towers – 12 months
Dynamic Message Boards – 48 months
Sign Bridges – 48 months
Cantilever Sign Bridges / Cantilever Mast Arms (no luminaire) – 24 months