ATTACHMENT 3 – MINNESOTA DEPARTMENT OF TRANSPORTATION BRIDGE INSPECTION MANUAL DATED MAY 2007

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Minnesota Department of Transportation

BRIDGE INSPECTION MANUAL

(Version 1.4 - May 2007)

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Section 1: Introduction

This manual is intended to provide a comprehensive guide for the inspection (and condition rating) of in-service bridges and culverts in Minnesota. This manual includes the NBI condition rating guidelines, the Pontis element condition rating guidelines, and explanations of other bridge inventory items displayed on the Mn/DOT Bridge Inspection Report.

This manual was developed by the Mn/DOT Bridge Office - a PDF version can be downloaded online on the Mn/DOT Bridge Office Web site: **http://www.dot.state.mn.us/bridge/** - it is listed under "Manuals". For questions, comments, or corrections, please contact Pete Wilson at ---------- ------ -- - ------ ----------

A bridge inspection includes examining the structure, evaluating the physical condition of the structure, and reporting the observations and evaluations on the bridge inspection report. Bridge inspections serve two purposes - to **ensure the safety** of the structure, and to **identify maintenance needs** for the structure. Mn/DOT currently uses two separate condition rating systems for bridges and culverts - the NBI condition ratings and the Pontis element condition ratings

- The NBI condition ratings describe the general overall condition of a bridge (see Section 2). This rating system was developed by the Federal Highway Administration (FHWA), and is outlined in the "FHWA Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges". The NBI condition ratings are used to calculate the Bridge Sufficiency Rating, which determines funding eligibility and priority for bridge replacement and rehabilitation

- The Pontis condition ratings divide a bridge into separate elements, which are then rated individually based upon the severity and extent of deterioration (see Section 3). This rating system was developed by the American Association of State Highway and Transportation Officials (AASHTO), and is outlined in the "AASHTO Guide for Commonly Recognized (CoRe) Structural Elements". The Pontis condition ratings provide input data for a Bridge Management System (BMS) 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).

Mn/DOT Bridge Office Inspection Contacts		
Mn/DOT Bridge Engineer	Daniel Dorgan	-------- ----- - ---
Mn/DOT Bridge Inspection Program Manager	Gary Peterson	-------- ----- - - -
Mn/DOT Bridge Management Unit (Pontis entry, Bridge Inspection & Inventory Reports, and other online Pontis Reports)	Jim Pierce	-------- ----- - - -
	Thomas Davidson	-------- ----- - - -
	Lisa Hartfiel	-------- ----- - - -
Mn/DOT Bridge Inspection Unit (Fracture Critical Bridge Inspection, Non-Destructive Testing, and Inspector Certification)	Todd Niemann	-------- ----- - - -
	Jennifer Zink	-------- ----- - - -
	Pete Wilson	-------- ----- - - -
	Bill Nelson	----------
	Ken Rand	-------- ----- - - -
	Fax	----------
Mn/DOT Bridge Load Rating Unit (Bridge Load Ratings and Load Postings)	Lowell Johnson	-------- ----- - - -
	Ed Lutgen	-------- ----- - - -
Bridge Hydraulics Unit (Scour Analysis & Scour Action Plans)	Andrea Hendrickson	-------- ----- - ---
	Petra DeWall	-------- ----- - ---
State Aid Bridge Unit (Plan Review & Funding Eligibility)	Dave Conkel	-------- ----- - ---
	Brian Homan	-------- ----- - ---
State Aid for Local Transportation (County/Local Underwater Bridge Inspections)	Paul Stine	-------- ----- - ---

Section 2: NBI Condition Ratings

2.1 NBI Bridge Condition Ratings

The NBI condition ratings describe the general overall condition of a bridge (or culvert) - these ratings are displayed on the Mn/DOT Bridge Inspection Report, and must be reviewed during each inspection. The NBI ratings are a key component of the "Bridge Sufficiency Rating", which is used to establish funding eligibility and priority for bridge replacement and rehabilitation. There are 5 NBI condition ratings - they are rated on a numerical scale of 1 to 9 (with 9 being "new" condition).

- NBI Deck Condition Rating (FHWA Item #58)
- NBI Superstructure Condition Rating (FHWA Item #59)
- NBI Substructure Condition Rating (FHWA Item #60)
- NBI Channel & Channel Protection Condition Rating (FHWA Item #61)
- NBI Culvert Condition Rating (FHWA Item #62)

A bridge is typically rated in three components (deck, superstructure, and substructure) - if the bridge spans over a waterway, the channel (FHWA Item #61) must also be rated.

- FHWA Item #58 describes the general overall condition of the deck (or slab) - this includes the underside of the deck and the wearing surface. While the deck includes the railings, curbs, sidewalks, expansion joints, and deck drains - these items should not be considered in this rating.

- FHWA Item #59 describes the general condition of the superstructure - this includes all structural components (slabs, arches, trusses, girders, or beams) located above (and including) the bearings. This rating should consider any deterioration, distress, misalignment, or collision damage.

- FHWA Item #60 describes the general overall condition of the substructure - this includes all structural components (piers, abutments, pilings, or footings) located below the bearings. This rating should consider any settlement, tipping, misalignment, undermining, or scour. Wingwalls or retaining walls (up to the first expansion or construction joint) can be included in this rating.

Culverts are rated as a single component (FHWA Item #62) - if water flows through a culvert, the channel (FHWA Item #61) must also be rated. The NBI Culvert Condition Rating describes the general overall condition of the culvert. 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 or aprons (up to the first construction joint) should be included in this rating.

The NBI condition ratings are entered in Pontis on the "Condition" display screen (use the drop-down selection screen). The NBI ratings from the previous inspection should carry over when adding a new inspection report. The following general guidelines apply to the NBI Condition Ratings…

- New bridges (or culverts) are entered as condition "9".
- If an NBI rating does not apply, it should be entered as "N N/A" (not "Unknown - NBI").
- While repaired bridge components should typically not be rated higher than condition "7", reconstructed bridge components can be rated as condition "9".
- An NBI rating of condition "5" or less implies that repairs are recommended (NBI ratings of condition "5" or less will also reduce the bridge sufficiency rating).
- An NBI rating of condition "3" or less implies that immediate repairs (or a new load rating) may be necessary.
- Temporary supports (shoring, bracing, or underpinning) should not improve the NBI rating.
- The load carrying capacity should not be considered when determining the NBI condition ratings.

2.1.1 NBI Deck Condition Rating (FHWA Item #58)

This rating should reflect the overall general condition of the deck (or slab) - this includes the underside of the deck and the wearing surface. The condition of the railings, sidewalks, curbs, expansion joints and deck drains should not be considered in this rating.

Code	NBI Deck Condition Description
N	**Not Applicable:** Use for culverts or bridges without decks (such as filled spandrel arches).
9	**Excellent Condition:** Deck is new condition (recently constructed).
8	**Very Good Condition:** Deck has superficial deterioration. • Concrete: superficial cracking, leaching, scale or wear (no delamination, spalling, or temporary patches). • Timber: superficial weathering - isolated splitting. • Steel: no corrosion (paint/protection system remains sound).
7	**Good Condition:** Deck has minor (isolated) deterioration. • Concrete: minor cracking, leaching, scale, or wear (isolated delamination or spalling). • Timber: minor weathering or splitting (no decay or crushing) - all planks are secure. • Steel: minor paint failure or corrosion (no section loss) - all connections are secure.
6	**Satisfactory Condition:** Deck has minor to moderate deterioration (no repairs are necessary). • Concrete: moderate cracking, leaching, scale, or wear (minor delamination or spalling). • Timber: moderate weathering or splitting (isolated decay or crushing) - some planks may be slightly loose. • Steel: moderate paint failure and/or surface corrosion (minor section loss) - some connections may have worked loose.
5	**Fair Condition:** Deck has moderate deterioration (repairs may be necessary). • Concrete: extensive cracking, leaching, scale, or wear (moderate delamination or spalling). • Timber: extensive weathering or splitting (moderate decay or crushing) - some planks may be loose, broken, or require replacement. • Steel: extensive paint failure and/or surface corrosion (moderate section loss) - several connections may be loose or missing, but all deck components remain secure.
4	**Poor Condition:** Deck has advanced deterioration (replacement or overlay should be planned). • Concrete: advanced cracking, leaching, scale, or wear (extensive delamination or spalling) - isolated full-depth failures may be imminent. • Timber: advanced weathering, splitting, or decay - numerous planks may be loose, broken, or require replacement. • Steel: advanced corrosion (significant section loss) - deck components may be loose or slightly out of alignment.
3	**Serious Condition:** Deck has severe deterioration - immediate repairs may be necessary. • Concrete: severe cracking, leaching, delamination, or spalling - full-depth failures may be present. • Timber: severe splitting, crushing or decay - majority of planks may need replacement. • Steel: severe and section loss - deck components may be severely out of alignment.
2	**Critical Condition:** Deck has failed - it may be necessary to close the bridge until repairs are completed.
1	**"Imminent" Failure Condition:** Bridge is closed - corrective action is required to open to restricted service.
0	**Failed Condition:** Bridge is closed - deck replacement is necessary.

2.1.2 NBI Superstructure Condition Rating (FHWA Item #59)

This rating should reflect the overall general condition of the superstructure - this includes all structural components located above (and including) the bearings.

Code	NBI Superstructure Condition Description
N	**Not Applicable:** Use for culverts.
9	**Excellent Condition:** Superstructure is in new condition (recently constructed).
8	**Very Good Condition:** Superstructure has superficial deterioration.
7	**Good Condition:** Superstructure has minor (isolated) deterioration. • Steel: minor corrosion, little or no section loss. • Concrete: minor scaling or non-structural cracking (isolated delamination or spalling). • Timber: minor weathering or splitting (no decay or crushing). • Masonry: minor weathering or cracking (joints have little or no deterioration).
6	**Satisfactory Condition:** Superstructure has minor to moderate deterioration. Members may be slightly bent or misaligned - connections may have minor distress. • Steel: moderate corrosion (section loss or fatigue cracks in non-critical areas). • Concrete: moderate scaling or non-structural cracking (minor delamination or spalling). • Timber: moderate weathering or splitting (minor decay or crushing). • Masonry: moderate weathering or cracking (joints may have minor deterioration).
5	**Fair Condition:** Superstructure has moderate deterioration. Members may be bent, bowed, or misaligned. Bolts, rivets, or connectors may be loose or missing, but connections remain intact. • Steel: extensive corrosion (initial section loss in critical stress areas). Fatigue cracks (if present) have been arrested or are not likely to propagate into critical stress areas. • Concrete: extensive scaling or cracking (structural cracks may be present), moderate spalling or delamination (reinforcement may have some section loss). • Timber: extensive weathering or splitting (moderate decay or crushing). • Masonry: extensive weathering or cracking (joints may have slight separation or offset).
4	**Poor Condition:** Superstructure has advanced deterioration. Members may be significantly bent or misaligned. Connection failure may be imminent. Bearings may be severely restricted. • Steel: significant section loss in critical stress areas. Un-arrested fatigue cracks exist that may likely propagate into critical stress areas. • Concrete: advanced scaling, cracking, or spalling (significant structural cracks may be present - exposed reinforcement may have significant section loss). • Timber: advanced splitting (extensive decay or significant crushing). • Masonry: advanced weathering or cracking (joints may have separation or offset).
3	**Serious Condition:** Superstructure has severe deterioration - immediate repairs or structural evaluation may be required. Members may be severely bent or misaligned - connections or bearings may have failed. • Steel: severe section loss or fatigue cracks in critical stress areas. • Concrete: severe structural cracking or spalling. • Timber: severe splitting, decay, or crushing. • Masonry: severe cracking, offset or misalignment.
2	**Critical Condition:** Superstructure has critical deterioration - primary structural elements may have failed (severed, detached or critically misaligned). Immediate repairs may be required to prevent collapse or closure. The load-carrying capacity may be severely reduced.
1	**"Imminent" Failure Condition:** Bridge is closed - superstructure in no longer stable (corrective action might return the structure to restricted service).
0	**Failed Condition** - Bridge is closed - superstructure is beyond the point of corrective action.

2.1.3 NBI Substructure Condition Rating (FHWA Item #60)

This rating should reflect the overall general condition of the substructure - this includes all structural components located below the bearings.

Code	NBI Substructure Condition Description
N	**Not Applicable:** Use for culverts or tunnels.
9	**Excellent Condition:** Substructure is in new condition (recently constructed).
8	**Very Good Condition:** Substructure has superficial deterioration.
7	**Good Condition:** Substructure has minor (isolated) deterioration. • Concrete: minor cracking, leaching, or scale (isolated delaminations or spalls). • Steel: minor paint failure and/or surface corrosion (little or no section loss). • Timber: minor weathering or splitting (no decay or crushing). • Masonry: minor weathering or cracking (joints have little or no deterioration).
6	**Satisfactory Condition:** Substructure has minor to moderate deterioration. Scour or erosion (if present) is minor and isolated. There may be slight movement or misalignment. • Concrete: moderate scaling, cracking, or leaching (minor delamination or spalling). • Steel: moderate paint failure and/or surface corrosion (minor section loss). • Timber: moderate weathering or splitting (minor decay or crushing). • Masonry: moderate weathering or cracking (joints may have minor deterioration).
5	**Fair Condition:** Substructure has moderate deterioration - repairs may be necessary. There may be moderate scour, erosion, or undermining. There may be minor settlement, movement, misalignment, or loss of bearing area. • Concrete: extensive scaling, cracking or leaching (isolated structural cracks may be present) - there may be moderate delamination or spalling. • Steel: extensive paint failure and/or surface corrosion (moderate section loss). • Timber: extensive weathering or splitting (moderate decay or crushing). • Masonry: extensive weathering or cracking (joints may have slight separation or offset).
4	**Poor Condition:** Substructure has advanced deterioration - repairs may be necessary to maintain stability. There may be extensive scour, erosion, or undermining. There may be significant settlement, movement, misalignment, or loss of bearing area. • Concrete: advanced scaling, cracking, or leaching (significant structural cracks may be present) - there may be extensive delamination or spalling. • Steel: advanced corrosion (significant section loss). • Timber: advanced splitting (significant decay or crushing). • Masonry: advanced weathering or cracking (joints may have separation or offset).
3	**Serious Condition:** Substructure has severe deterioration. Immediate corrective action may be required. Scour, erosion, or undermining may have resulted in severe settlement, movement, misalignment, or loss of bearing area. • Concrete: severe spalling or structural cracking. • Steel: severe section loss. • Timber: severe decay or crushing. • Masonry: severe cracking, offset or misalignment.
2	**Critical Condition:** Substructure has critical damage or deterioration (near the point of collapse) - it may be necessary to close the bridge until corrective action is completed. Scour may have removed substructure support.
1	**Imminent Failure Condition:** Bridge is closed to traffic due to substructure failure - corrective action may restore the bridge to light service.
0	**Failed Condition:** Bridge is closed due to substructure failure - beyond corrective action (replacement required).

2.1.4 NBI Channel/Channel Protection Condition Rating (FHWA Item #61)

This rating should reflect the overall general condition of the waterway flowing below the bridge (or running through the culvert) - even if the channel is occasionally dry. This rating can be based upon findings from routine visual inspections, soundings, or underwater inspections.

This rating includes the channel and banks below the bridge, as well as immediately upstream and downstream of the bridge (typically those areas visible from the bridge). Changes in the channel - such as aggradation (rising of the channel due to sedimentation), degradation (lowering of the channel due to erosion), or lateral stream migration that might adversely affect the bridge should be considered in this rating. The presence drift in the channel, debris lodged against the bridge, or sediment inside culvert barrels should also be considered in this rating. *Note: if the bridge is over a navigable waterway (FHWA Item #38 coded as "1"), the condition of substructure protection devices (such as dolphins, fenders, and shear walls) must be rated using FHWA Item #111.*

Code	NBI Channel Condition Description
N	**Not Applicable:** Bridge is not over a waterway.
9	**Excellent Condition:** There are no noticeable or noteworthy deficiencies.
8	**Very Good Condition:** Channel banks are protected (or well vegetated) - there is little or no erosion. Control structures and protection devices (if present) have little or no deterioration. Any drift or debris in the channel is incidental. Culvert barrel has little or no sediment.
7	**Good Condition:** Channel has no notable aggradation, degradation, or lateral movement. There is no notable scour around the bridge substructure. The banks may have minor erosion - bank protection (if any) may have minor deterioration. Control structures and/or protection devices may have minor deterioration. There may be minor drift or debris in the channel. Culvert barrel may have minor sediment.
6	**Satisfactory Condition:** Channel may have minor aggradation, degradation, or lateral movement. The channel banks may have moderate erosion or slumping - bank protection may have moderate deterioration. Control structures and/or protection devices may have moderate deterioration. Drift or debris in the channel may be slightly restricting the channel. Culvert barrel may have moderate sediment.
5	**Fair Condition:** Channel may have moderate aggradation, degradation, or lateral movement, but the bridge and approaches have not yet been adversely affected. The channel banks may have extensive erosion - the bank protection may have extensive deterioration. Control structures and/or protection devices may have extensive deterioration, but are functioning as intended. Debris in the channel (or sediment in the culvert barrel) is restricting the channel and should be removed.
4	**Poor Condition:** Aggradation, degradation, or lateral movement of the channel may be adversely affecting the bridge and/or approaches. Channel banks may have severe erosion - the bank protection may have severe deterioration. Control structures and/or protection devices may be deteriorated to the extent that they are no longer functioning as intended. Large accumulations of debris or sediment are severely restricting the channel, and should be removed immediately.
3	**Serious Condition:** Aggradation, degradation, or lateral movement has altered the channel to the extent that the bridge (or approach roadway) is threatened. Bank protection has failed. Control structures and/or protection devices have been destroyed.
2	**Critical Condition:** Aggradation, degradation, or lateral movement has altered the channel to the extent that the bridge is near a state of collapse. It may be necessary to close the bridge until corrective action is completed.
1	**Bridge closed due to channel failure:** Corrective action may restore bridge to light service.
0	**Bridge closed due to channel failure:** Replacement necessary.

2.1.5 NBI Culvert Condition Rating (FHWA Item #62)

This rating should reflect the overall general condition of the culvert. If a structure is classified as a "culvert", the NBI condition ratings for deck, superstructure, and substructure must all be rated as "N".

Code	NBI Culvert Condition Description
N	**Not Applicable:** Structure is not a culvert.
9	**Excellent Condition:** Culvert is new condition (recently constructed).
8	**Very Good Condition:** Culvert has superficial and/or isolated deterioration.
7	**Good Condition:** Culvert has minor (isolated) deterioration. Joints are sound and properly aligned (no leakage or backfill infiltration). Footings have no undermining. • Concrete/Masonry: minor weathering/scaling, cracking, or leaching (isolated spalling) • Steel: minor corrosion (little or no section loss) - barrel has no distortion. • Timber: minor splitting (no decay, crushing, or sagging).
6	**Satisfactory Condition:** Culvert has minor to moderate deterioration. Joints may have minor separation or misalignment (slight leakage or backfill infiltration). • Concrete/Masonry: moderate weathering/scaling, cracking, or leaching (minor spalling). • Steel: moderate corrosion (minor section loss) - barrel may have minor distortion (seams may have minor distress, but no cracking). • Timber: moderate splitting (minor decay, crushing, or sagging).
5	**Fair Condition:** Culvert has moderate deterioration - repairs may be required, but the culvert is structurally sound and functioning as intended. Joints may have separation or misalignment (moderate leakage or backfill infiltration). Footings may be partially undermined (minor settlement). Embankments remain intact (roadway has no notable settlement). • Concrete/Masonry: extensive weathering/scaling, cracking, or leaching (moderate spalling). • Steel: extensive corrosion (any significant section loss is isolated) - barrel may have moderate distortion (seams may have missing bolts or isolated cracking). • Timber: extensive splitting (moderate decay, crushing, or sagging).
4	**Poor Condition:** Culvert has advanced deterioration - structural evaluation or repairs may be necessary (the structural integrity and/or functional capacity of the culvert may be slightly reduced). Footings may have significant undermining or settlement. Loss of backfill may have resulted in slight settlement of the roadway or embankment. • Concrete/Masonry: advanced weathering, cracking, leaching, or scaling (significant spalling). Joints may have significant separation, misalignment, or leakage. • Steel: advanced corrosion (significant section loss) - barrel may have significant distortion (seams may have extensive cracking or isolated failures). • Timber: advanced splitting (significant decay, crushing, or sagging).
3	**Serious Condition:** Culvert has serious deterioration - immediate repairs or corrective action may be required (the structural integrity and/or functional capacity of the culvert may be significantly reduced). Joints may have severe deterioration, misalignment, offset, separation, or leakage. Loss of backfill may have resulted in significant settlement or undermining of the roadway or embankment. Footings may have severe undermining or settlement. • Concrete/Masonry: severe weathering, cracking, or spalling. • Steel: severe section loss - barrel may have severe distortion (seams may have failed). • Timber: severe decay, crushing, or sagging.
2	**Critical Condition:** Culvert has critically advanced deterioration (near the point of collapse) - it may be necessary to close the roadway until corrective action is completed.
1	**"Imminent" Failure Condition:** Culvert is closed - corrective action may restore to light service
0	**Failed Condition:** Culvert is closed - replacement is necessary.

2.2 Bridge Appraisal Ratings & Other Items

The Mn/DOT Bridge Inspection Report displays two of the NBI Bridge Appraisal Ratings, as well as some additional structure inventory items. This section includes explanations of some of these items - they should be periodically reviewed for accuracy.

2.2.1 Waterway Adequacy Appraisal Rating (FHWA Item #71)

This rating is a general assessment of the waterway opening with respect to the passage of flow through the bridge. This rating is based upon the frequency of "overtopping" of the bridge and approach (and the resultant traffic delays). The functional class of the roadway is also taken into consideration. Site conditions may warrant somewhat higher or lower ratings than indicated by the table (e.g. flooding of an urban area due to a restricted bridge opening). *Note: When entering new inspections into the Pontis database, this item is displayed under the "Condition" tab.*

The descriptions given in the table mean the following…

Chances of Overtopping
Remote: greater than 100 years
Slight: 11 to 100 years
Occasional: 3 to 10 years
Frequent: less than 3 years

Traffic Delays
Insignificant: Minor inconvenience (impassable for a few hours)
Significant: Traffic delays of up to several days
Severe: Long-term traffic delays with resulting hardship

"Freeboard" is defined as the distance from the bottom of the superstructure to the water surface (at the water level of the 50-year frequency design storm).

Waterway Adequacy Appraisal Rating (FHWA Item #71)			
Functional Classification			Description
Principal Arterials - Interstates, Freeways, or Expressways	Other Principal and Minor Arterial and Major Collectors	Minor Collectors and Local Roads	
N	N	N	Bridge not over a waterway.
9	9	9	Bridge deck and roadway approaches above floodwater elevations (high water). Chance of overtopping is remote.
8	8	8	Bridge deck above roadway approaches. Slight chance of overtopping roadway approaches. Greater than 3 ft. of freeboard.
6	6	7	Bridge deck above roadway approaches. Slight chance of overtopping bridge deck and roadway approaches. 2 to 3 ft. of freeboard.
4	4	6	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with insignificant traffic delays. 1 to 2 ft. of freeboard.
3	4	5	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches with significant traffic delays. Less than 1 ft. of freeboard.
2	3	4	Occasional overtopping of roadway approaches with significant traffic delays.
2	2	3	Frequent overtopping of roadway approaches with significant traffic delays.
2	2	2	Occasional or frequent overtopping of bridge deck and roadway approaches with severe traffic delays.
0	0	0	Bridge closed.

2.2.2 Approach Roadway Alignment Appraisal Rating (FHWA Item #72)

FHWA Item #72 is a general assessment of the approach roadway alignment - this item identifies those bridges that do not function properly or adequately due to the approach alignment. While this rating will typically remain constant, it should be reviewed if the bridge approaches have been reconstructed. This rating only applies to the roadway passing over the bridge (not the roadway passing below the bridge). Railroad or pedestrian bridges crossing over a roadway should be rated as "N".

This rating is based upon the speed reduction required (due to the vertical or horizontal approach alignment) by a typical vehicle using the roadway. *Note: Speed reductions necessary due to structure width shall not be considered when evaluating this item.*

Approach Roadway Alignment Appraisal Rating (FHWA Item #72)	
Code	**Description**
N	Not Applicable (use for railroad or pedestrian bridges)
9	**This rating code should not be used**
8	No speed reduction required
7	Minor sight distance problems with no speed reduction required
6	Very minor speed reduction required (0-3 MPH for a typical vehicle using the roadway)
5	Minor speed reduction required (3-5 MPH for a typical vehicle using the roadway)
4	Significant speed reduction required (5-10 MPH for a typical vehicle using the roadway)
3	Intolerable alignment requiring a substantial reduction in the operating speed (10-20 MPH for a typical vehicle using the roadway)
2	Severe vertical or horizontal alignment problems, such as a sharp vertical or horizontal curve immediately adjacent to the bridge (Speed reduction of 20 MPH or greater for a typical vehicle using the roadway)
1	**This rating code should not be used**
0	Bridge Closed

2.2.3 Bridge Deficiency Status

If a bridge or culvert has been designated as Structurally Deficient or Functionally Obsolete, this will be displayed on the Mn/DOT Bridge Inspection Report (this is automatically calculated). The FHWA designates a bridge as "Structurally Deficient" if it meets one of the following conditions:

1. An NBI condition rating of "4" or less for the Deck, Superstructure, Substructure, or Culvert; or
2. An NBI appraisal rating of "2" or less for Structural Evaluation or Waterway Adequacy.

The FHWA designates a bridge as "Functionally Obsolete" if it meets one of the following conditions:

1. An NBI appraisal rating of "3" or less for Deck Geometry, Vertical & Horizontal Underclearances, or Approach Roadway Alignment; or
2. An NBI appraisal rating of "3" for Structural Evaluation or Waterway Adequacy.

Note: a bridge designated as "structurally deficient" is excluded from consideration as being "functionally obsolete".

2.2.4 Bridge Sufficiency Rating

The bridge sufficiency rating is a based upon a percentage scale of 0%-100% (with 100% being an entirely sufficient bridge). The bridge sufficiency rating is used to establish funding eligibility and priority for bridge replacement and rehabilitation. As a general rule, a sufficiency rating of 80% or less is required to be eligible for bridge rehabilitation, and a sufficiency rating of 50% or less is required to be eligible for bridge replacement. *Note: The bridge sufficiency rating is only calculated for bridges (or culverts) that carry vehicular traffic - it is not calculated for railroad or pedestrian bridges.*

The bridge sufficiency rating is calculated automatically - it takes into consideration the structural adequacy, functional capacity, and essentiality for public use of the bridge (the formula is explained in Appendix B of the FHWA Recording & Coding Guide). While the NBI condition ratings are a key component of the bridge sufficiency rating, only NBI condition ratings of "5" or less will reduce the bridge sufficiency rating. Other factors used to calculate the bridge sufficiency rating include the load-carrying capacity, the NBI appraisal ratings, the average daily traffic, and the detour length.

2.2.5 Mn/DOT Scour Code

The Mn/DOT scour code indicates the bridge's vulnerably to scour - the scour code (along with an abbreviated description) is displayed on Mn/DOT Inspection Report. The FHWA requires that all bridges over water with a length of 20 feet or greater be reviewed for scour - in Minnesota, this process consists of a primary and secondary scour screening, and if necessary, a more thorough scour evaluation. The "Bridge Scour Evaluation Procedure for MN Bridges" can be downloaded on the Mn/DOT Bridge Office web site - this outlines the scour screening and evaluation process, and includes examples of Scour Action Plans.

- If the Mn/DOT scour code is "F, G, or J" - additional scour analysis (and re-coding) is required.
- If the Mn/DOT scour code is "G, K, O, P, R, or U", a "Scour Action Plan" must be established to outline procedures for monitoring or closing the bridge during high water events.
- If the Mn/DOT scour code is "B, D, or U", extensive scour has occurred at the bridge foundations (they may be unstable - failure may be imminent). If the bridge is still open to traffic, it should be closely monitored until scour countermeasures have been installed.

If a bridge is Scour Critical or requires a Scour Action Plan (Mn/DOT scour code of "D, G, K, O, P, R or U"), the Pontis Scour smart flag (element #361) will be automatically added to the inspection report. This is a reminder to the inspector to note any evidence of scour. *However, the inspector should be aware that scour problems can develop even on bridges listed as "low risk".*

Code	Mn/DOT Scour Code Description
A	Bridge is not over a waterway.
B	Bridge is closed to traffic; field review indicates that failure of piers and/or abutments due to scour is imminent or has occurred.
C	Bridge is closed to traffic for reasons other than scour. Prior to reopening, the bridge must be evaluated for scour and the scour code must be updated.
D	Bridge is **scour critical**; field review indicates that extensive scour has occurred at bridge foundations. Immediate action is required to provide scour countermeasures.
E	Culvert structure: Scour calculation, evaluation, and/or screening have not been made. *Note: the FHWA does not require scour evaluation of structures less than 20 feet in length.*
F	Bridge structure: Scour calculation, evaluation, and/or screening **have not** been made. All substructure foundations are known.
G	Scour calculation, evaluation and/or screening **have not** been made. Bridge on unknown foundations.
H	Bridge foundations (including piles) are well above flood water elevations.

Code	Mn/DOT Scour Code Description
I	Bridge screened, determined to be low risk for failure due to scour.
J	Bridge screened - determined to be scour susceptible (further evaluation must be completed).
K	Bridge screened, determined to be of limited risk to public, monitor (Scour Action Plan) in lieu of evaluation and close if necessary.
L	Scour evaluation complete, bridge judged to be low risk for failure due to scour.
M	Bridge foundations determined to be stable for calculated scour conditions; calculated scour depth from the scour prediction equations is above top of footing.
N	Bridge foundations determined to be stable for calculated scour conditions; calculated scour depth from the scour prediction equations is within limits of footing or piles.
O	Bridge foundations determined to be stable for predicted scour conditions; Scour Action Plan requires additional action.
P	Countermeasures have been installed to correct a previously existing problem with scour. **Bridge is no longer scour critical.** Scour countermeasures should be inspected at least once every 4 years and after major flows, or as recommended in the Scour Action Plan. Report any changes that have occurred to countermeasures.
R	Bridge has been evaluated and is **scour critical**. Scour Action Plan recommends monitoring the bridge during high flows and closing if necessary.
U	Bridge has been evaluated and is **scour critical**. Scour Action Plan recommends this bridge as a priority for installation of countermeasures. Until countermeasures are installed, monitor bridge during high flows and close if necessary.

2.2.6 Structure Open, Posted, or Closed to Traffic

This item describes the current operational status of the structure (opened, posted, or closed to traffic) - it corresponds with FHWA Item #41. The inspector should verify that this item is correct - the item is coded as follows (only an abbreviated description will be displayed on the Mn/DOT Inspection Report).

Code	Description
A	Bridge is open to traffic (no load restrictions) - this includes pedestrian or railroad bridges.
B	Bridge is open to traffic - load posting is recommended but has not been legally implemented (all signs not in place).
D	Bridge is open to traffic, but would be posted or closed without temporary shoring or supports.
E	Bridge is open to traffic, but is a temporary structure intended to carry legal loads until the original structure is rehabilitated (or a new structure is constructed).
G	New structure - not yet open to traffic.
K	Bridge is closed to all traffic.
P	Bridge is posted with a load restriction. This includes bridges with more than one restriction, or temporary bridges with a load restriction.
R	Bridge is posted with other load-capacity restrictions (such as speed, number of vehicles on bridge, etc.).

2.2.7 Bridge Signage (Required)

The bridge inspection report displays any signage (load posting, traffic control, horizontal control, or vertical clearance) required at the bridge site. This is based upon current structure inventory information - it is the responsibly of the agency with inspection jurisdiction to verify these signing requirements. Sign standards and guidelines are outlined in the **Mn/DOT Traffic Engineering Manual** and the **Minnesota Manual on Uniform Traffic Control Devices**. Any signage item listed as "unknown" should be revised.

Load Posting Signs: Every bridge must be rated (in accordance with the "AASHTO Manual for Condition Evaluation and Load & Resistance Factor Rating of Highway Bridges") to determine its safe live load carrying capacity. If maximum legal load exceeds the bridge capacity at the operating load level, the bridge must be posted with a weight restriction. A new load rating is required if the structure has deteriorated significantly, has been severely damaged, has a significant increase in dead load (such as a new overlay), or if the allowable legal load is increased. The Timber Hauler's Bill has resulted in some bridges being posted with a "Permit Weight Limit" that otherwise would not have a weight restriction.

R12-1A
24" x 26"

R12-5
30" x 36"

R12-5
Permit
36" x 36"

R12-5
Supplements
30" x 9"

R12-X2
60" x 36"

Load posting signs (R12-1A, R12-5 or R12-5 Permit) must be placed either on or immediately in front of the bridge. Advanced signs (R12-5 Supplement or R12-X2) should be placed at the nearest intersecting road (or a wide point in the road) at which an overweight vehicle can detour or turn around. Requirements for load posting signs are coded and displayed as follows…

Load Posting Signage (Required)		
Code	**Description**	**Display**
0	No Load Posting Signs are Required	NOT REQUIRED
1	Vehicle Limit Only (type R12-1A)	VEHICLE ONLY
2	Vehicle and Semi-Trailer Limits (such as type R12-5)	VEHICLE & SEMI
3	Bridge Closed (type R11-2A)	BRIDGE CLOSED
4	Permit Weight Limit (type R12-5 Permit)	PERMIT

Traffic Control Signs: Some bridges require traffic control signs (speed or lane restrictions) that are related to weight restrictions. Bridge speed limits signs (type R2-X5) may be required to reduce impact loads (this refers only to a speed limit less than the speed limit on the approach roadways). Narrow bridges may require lane restriction signs such as "Trucks Must Not Meet on Bridge" (type R12-X3) or "Vehicles Must Not Meet on Bridge" (type R12-X3A). Requirements for traffic control signs are coded and displayed as follows…

R12-5
24” x 36”

R12-X3
36” x 24”

R12-X3
42” x 24”

Traffic Control Signage (Required)		
Code	**Description**	**Display**
0	No Traffic Restriction Signs Required	NOT REQUIRED
1	Bridge Speed Limit (Type R2-X5)	SPEED LIMIT
2	Lane Restriction (Trucks/Vehicles Must Not Meet on Bridge)	ONLY 1 TRUCK
3	Combination of 1 & 2	SPEED LIMIT & 1 TRUCK

Horizontal Control Signs: Abutments, piers, trusses, or railings located within the width of the approach shoulders should be delineated by Type 3 Object Markers (OM-3L, OM-3C, or OM-3R). These signs have alternating black & yellow stripes sloping downward toward the side of the obstruction on which traffic is to pass.

Type 3 Object Markers
(12” x 36”)

OM-3L

OM-3C

OM-3R

W5-2
(36” x 36”)

W5-3
(36” x 36”)

A narrow bridge sign (type W5-2 or W5-2A) should be placed in advance of any bridge (or culvert) with a clearance width less than the approach roadway width. A one lane bridge sign (W5-3) should be placed in advance of 2-lane bridges (or culverts) with a clearance width of 18 ft. or less. Requirements for horizontal control signs are coded and displayed as follows…

Horizontal Clearance Signage (Required)		
Code	**Description**	**Display**
0	No Horizontal Clearance Signs Required	NOT REQUIRED
1	Type 3 Object Markers(Hazard Markers)	OBJECT MARKERS
2	Width Restrictions (Narrow Bridge or One Lane Bridge)	WIDTH RESTRICTION
3	Combination of 1 & 2	OBJECT MARKERS & WIDTH

Vertical Clearance Signs: The maximum vehicle height in the state of Minnesota is 13’-6”. Low clearance signs (type W12-2 or W12-2P) must be placed either on or immediately in front of any bridge with a vertical clearance of 14’-6” or less. On arch bridges (or when the underclearance varies greatly),

the W12-X-2 Vertical Clearance sign shall be used (the arrow indicates the location of the height specified on the sign). Advanced signs should be placed at the nearest intersecting road (or wide point in the road) at which an over height vehicle can detour or turn around.

W12-2
36” x 36”

W12-2P
84” x 24”

W12-X2
48” x 24”

Low clearance signs should display the vertical clearance to the nearest 1” (not exceeding the actual clearance) - an additional 3” allowance for frost heaving should be reflected in the signing. Bridge clearances should be checked periodically (especially if the roadway has been resurfaced), and the current posted clearance should be noted on the inspection report! Requirements for vertical clearance signs are coded and displayed as follows…

Vertical Clearance Signage (Required)		
Code	**Description**	**Display**
N	Not Applicable (no vertical restrictions)	NOT APPLICABLE
0	No Vertical Clearance Signs Required (14’-6” or greater)	NOT REQUIRED
1	Vertical Clearance Restriction on Roadway (type W12-2 or W12-2p)	ROADWAY RESTRICTION
2	Vertical Clearance Restriction on Shoulder (Arch Bridges - type W12-X2)	SHOULDER RESTRICTION

2.2.8 Unsound Wearing Surface Percentage

This item represents the amount of unsound (deteriorated) wearing surface, expressed as a percentage of the total deck area. This item only applies to concrete decks (and concrete slabs), and should correlate with the condition rating of the corresponding Pontis concrete deck (or slab) element. This quantity may be estimated from field observations, or calculated from a deck condition survey (such as chaining or ground penetrating radar). “Unsound” wearing surface includes areas with delamination, spalling, potholes, severe scale, or other significant deterioration. Temporary patches (such as those performed by maintenance personal) should be considered to be unsound. Long-term patches (such as those performed under a mill & patch contract) should not be considered to be unsound until these repaired areas have begun to deteriorate.

2.2.9 Unsound Paint Percentage

This item indicates the estimated quantity of “unsound” (deteriorated) paint, expressed as a percentage of the total painted area. The painted area only includes painted steel structural members such as beams, trusses, or arches (do not include bridge railings). This includes areas with complete paint system failure (exposed and rusted metal), or areas with finish coat deterioration (flaking, cracking, blistering, or severe staining).*Note: this item may also be used for bridges constructed of weathering steel (that are rated using weathering steel elements. However, only the “high corrosion areas” (typically those areas within 7 ft. of a deck joint) should be considered when determining the total painted area. Paint failure outside the “high corrosion” areas should be considered to be an aesthetic issue, and should not be considered in this percentage.*

Section 3: Pontis Element Condition Ratings

3.1 Introduction to Pontis Element Condition Ratings

3.1.1 Background of Pontis

The Pontis 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 any deterioration. This rating system was developed by the American Association of State Highway and Transportation Officials (AASHTO), and is outlined in the "AASHTO Guide for Commonly Recognized (CoRe) Structural Elements".

Pontis element condition ratings provide input data for a Bridge Management System (BMS) which allows computer projections of deterioration rates, providing cost-effective options for bridge maintenance, rehabilitation, or replacement. Pontis is intended to be a source of information (and qualitative backing) for engineers and managers responsible for long-range bridge improvement programs. Mn/DOT adopted an element based bridge inspection format in 1994 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.

An "element" refers to structural members (beams, pier columns, decks, etc.), or any other components (railings, expansion joints, approach panels, etc.) commonly found on a bridge. This manual includes approximately 150 elements - this includes the AASHTO CoRe (commonly recognized) elements, as well as elements added by Mn/DOT to better represent the bridge types and components found in Minnesota.

3.1.2 Pontis Element Types

Pontis elements are divided into five groups, depending upon their structural function…

- Deck Elements (decks, slabs, railings, and expansion joints)
- Superstructure Elements (girders, beams, arches, trusses, and bearings)
- Substructure Elements (abutments, wingwalls, pilings, columns, pier caps and pier walls)
- Culvert Elements (culverts and culvert headwalls/wingwalls)
- Miscellaneous Elements ("smart flags" and miscellaneous bridge elements)

Pontis elements are also divided into six material groups - the condition rating descriptions (and rating scales) will vary according to the material type.

- Painted Steel
- Unpainted Weathering Steel
- Reinforced Concrete
- Pre-stressed (or Post-Tensioned) Concrete
- Timber
- Masonry, Other Material, or Combination of Materials

Note: "Smart Flag" elements identify conditions or problems present on a bridge that are not adequately addressed by the conventional Pontis elements. Some smart flags refer to specific problems that may warrant special attention or follow-up action, while some smart flags provide detailed information about the condition of specific bridge elements or materials.

3.1.3 Pontis Element Quantities & Ratings

Pontis element quantities may be expressed in two ways…

- Linear Feet (LF) elements display the total length of the element present on the bridge. For example, on a 100 ft. long bridge with five beam lines, the beam quantity would be 500 LF.
- Each (EA) elements display the total quantity of the element present on the bridge. For example, on a bridge with three piers (and three columns on each pier), the column quantity would be "9".

Pontis elements are rated on a scale of 1-3, 1-4, or 1-5 (depending upon the element type and material). In all cases, condition state 1 is the best condition, with condition state 3, 4, or 5 being the worst condition (this is the reverse of the NBI condition ratings).

If the severity of deterioration varies within a particular element, it may be rated using more than one condition state. For 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. 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). For 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. *Note: while deck elements are displayed as a "SF" quantity, the entire quantity must be rated as one condition state.*

3.1.4 Pontis Element Display and Entry

Only the Pontis elements that have been entered for a bridge will be displayed on the Mn/DOT Bridge Inspection Report. The display order is determined by the element structural type - deck elements will be displayed first, followed by superstructure elements, substructure elements, culvert elements and then miscellaneous elements. The element condition ratings for the current inspection (as well as the previous inspection) will be displayed on the inspection report (in "LF" or "Each quantity). Inspection notes pertaining to each element are displayed directly below each element.

When entering a new inspection into the Pontis system, elements may be added, deleted, or edited the on the "Condition" display screen. *Note: be sure that the arrow cursor along the left side of the display screen is aligned with the proper element.*

- Elements may be added by clicking on the "Create Element" button - the element can then be selected from the drop-down list (the element quantity and environment factor should also be entered).
- To change the quantity or environment factor for an existing element, click on the "Edit Element" button.
- Elements can be deleted by clicking on the "Remove Element" button.
- Element condition ratings can be changed by clicking on the "up/down" arrows for each condition state. *Note: Be aware that elements quantities may be displayed as either "Quantity" or "Percent" and can be expressed as either "English" or "Metric" units (verify the settings before editing the condition ratings).*
- Element inspection notes can be entered by clicking on the icon near the lower left corner of the display screen (check to see that the arrow cursor is aligned with the proper element). *Note: general inspection notes are entered on the "Notes" display screen.*

3.1.5 Structure Units

Large or complex bridges that incorporate more than one structure type can be divided into structure units (a structure unit may consist of an individual span or a group of spans with the same structure type). *Note: if you wish to divide a bridge into structure units, please contact the Mn/DOT Bridge Data Office.*

3.2 Mn/DOT Pontis Element List

This element list is arranged in groups based upon the element type or the material - this is essentially the same order in which the element condition rating descriptions are arranged in this manual. Each Pontis element is assigned a number - AASHTO CoRe deck elements are numbered between 1 and 99, AASHTO CoRe superstructure elements are numbered between 100 and 199, and AASHTO CoRe substructure elements are numbered between 200 and 299. Smart Flag elements and elements added by Mn/DOT are numbered between 300 and 999 (elements higher than 370 were added by Mn/DOT).

Mn/DOT Pontis Element List					
Element #	**Element Description**	**Element Type**	**Units**	**Rating Scale**	**Page**
Concrete Decks					
12	Top of Concrete Deck with Uncoated Rebar (No Overlay)	Deck	Each	1-5	25
13	Bituminous Overlay (Concrete Deck)	Deck	Each	1-5	26
14	Bituminous Overlay with Membrane (Concrete Deck)	Deck	Each	1-5	26
18	Latex, Epoxy, or Thin Overlay (Concrete Deck)	Deck	Each	1-5	26
22	Low Slump Overlay (Concrete Deck with Uncoated Rebar)	Deck	Each	1-5	25
26	Top of Concrete Deck with Epoxy Reinforcement (No Overlay)	Deck	Each	1-5	25
27	Top of Concrete Deck with Cathodic Protection System	Deck	Each	1-5	25
377	Low Slump Overlay (Concrete Deck with Epoxy Rebar)	Deck	Each	1-5	25
Concrete Slabs					
38	Top of Concrete Slab with Uncoated Rebar (No Overlay)	Deck	Each	1-5	25
39	Bituminous Overlay (Concrete Slab)	Deck	Each	1-5	26
40	Bituminous Overlay with Membrane (Concrete Slab)	Deck	Each	1-5	26
44	Latex, Epoxy, or Thin Overlay (Concrete Slab)	Deck	Each	1-5	26
48	Low Slump Overlay (Concrete Slab with Uncoated Rebar)	Deck	Each	1-5	25
52	Top of Concrete Slab with Epoxy Reinforcement (No Overlay)	Deck	Each	1-5	25
53	Top of Concrete Slab with Cathodic Protection System	Deck	Each	1-5	25
378	Low Slump Overlay (Concrete Slab with Epoxy Rebar)	Deck	Each	1-5	25
405	Top of CIP Concrete Voided Slab (No Overlay)	Deck	Each	1-5	25
406	Low Slump Overlay (CIP Concrete Voided Slab)	Deck	Each	1-5	25
Timber Decks & Slabs					
31	Timber Deck (No Overlay)	Deck	Each	1-4	27
32	Timber Deck with Bituminous (AC) Overlay	Deck	Each	1-4	27
54	Timber Slab (No Overlay)	Deck	Each	1-4	27
55	Timber Slab with Bituminous (AC) Overlay	Deck	Each	1-4	27
Other Deck Types					
28	Steel Grid Deck - Open	Deck	Each	1-5	28
29	Steel Grid Deck - Concrete Filled	Deck	Each	1-5	28
30	Corrugated, Orthotropic, Exodermic, or Other Deck	Deck	Each	1-5	28
401	Steel Ballast Plate Deck (Railroad Bridges)	Deck	Each	1-5	29
Deck Joints					
300	Strip Seal Deck Joint	Deck	LF	1-3	30
301	Poured Deck Joint	Deck	LF	1-3	30
302	Compression Seal Deck Joint	Deck	LF	1-3	30
303	Assembly Deck Joint (with or without seal)	Deck	LF	1-3	31
304	Open Deck Joint	Deck	LF	1-3	31
410	Modular Deck Joint	Deck	LF	1-3	31
411	Finger Deck Joint	Deck	LF	1-3	32
412	Approach Relief Joint	Deck	LF	1-3	32
Roadway Approaches					
320	Concrete Approach Slab (Bituminous Wearing Surface)	Deck	Each	1-4	33
321	Concrete Approach Slab (Concrete Wearing Surface)	Deck	Each	1-4	33
407	Bituminous Approach Roadway	Deck	Each	1-4	33
408	Gravel Approach Roadway	Deck	Each	1-4	33

Mn/DOT Pontis Element List					
Element #	**Element Description**	**Element Type**	**Units**	**Rating Scale**	**Page**
Bridge Railings					
330	Metal Bridge Railing (Uncoated or Unpainted)	Deck	LF	1-4	34
331	Reinforced Concrete Bridge Railing	Deck	LF	1-4	34
332	Timber Bridge Railing	Deck	LF	1-3	34
333	Masonry, Other, or Combination Material Bridge Railing	Deck	LF	1-3	35
334	Metal Bridge Railing (Coated or Painted)	Deck	LF	1-5	35
409	Chain Link Fence	Deck	LF	1-5	35
Painted Steel Elements					
102	Painted Steel Box Girder	Superstructure	LF	1-5	36
107	Painted Steel Girder or Beam	Superstructure	LF	1-5	36
113	Painted Steel Stringer	Superstructure	LF	1-5	36
121	Painted Steel Through Truss - Bottom Chord	Superstructure	LF	1-5	36
126	Painted Steel Through Truss - Upper Members	Superstructure	LF	1-5	36
131	Painted Steel Deck Truss	Superstructure	LF	1-5	36
141	Painted Steel Arch	Superstructure	LF	1-5	36
152	Painted Steel Floorbeam	Superstructure	LF	1-5	36
202	Painted Steel Column	Substructure	Each	1-5	36
231	Painted Steel Pier Cap	Substructure	LF	1-5	36
384	Painted Steel Arch Spandrel Column	Superstructure	Each	1-5	36
419	Painted Steel Piling	Substructure	Each	1-5	36
Weathering Steel Elements					
101	Weathering Steel Box Girder	Superstructure	LF	1-4	37
106	Weathering Steel Girder or Beam	Superstructure	LF	1-4	37
112	Weathering Steel Stringer	Superstructure	LF	1-4	37
120	Weathering Steel Through Truss - Bottom Chord	Superstructure	LF	1-4	37
125	Weathering Steel Through Truss - Upper Members	Superstructure	LF	1-4	37
130	Weathering Steel Deck Truss	Superstructure	LF	1-4	37
140	Weathering Steel Arch	Superstructure	LF	1-4	37
151	Weathering Steel Floorbeam	Superstructure	LF	1-4	37
201	Weathering Steel Column	Substructure	Each	1-4	37
225	Weathering Steel Piling	Substructure	Each	1-4	37
230	Weathering Steel Pier Cap	Substructure	LF	1-4	37
413	Weathering Steel Arch Spandrel Column	Superstructure	Each	1-4	37
Reinforced Concrete Elements					
105	Reinforced Concrete Box Girder	Superstructure	LF	1-4	38
110	Reinforced Concrete Girder or Beam	Superstructure	LF	1-4	38
116	Reinforced Concrete Stringer	Superstructure	LF	1-4	38
144	Reinforced Concrete Arch	Superstructure	LF	1-4	38
155	Reinforced Concrete Floorbeam	Superstructure	LF	1-4	38
205	Reinforced Concrete Column	Substructure	Each	1-4	38
210	Reinforced Concrete Pier Wall	Substructure	LF	1-4	38
215	Reinforced Concrete Abutment	Substructure	LF	1-4	38
220	Reinforced Concrete Footing	Substructure	Each	1-4	38
227	Reinforced Concrete Piling	Substructure	Each	1-4	38
234	Reinforced Concrete Pier Cap	Substructure	LF	1-4	38
375	Precast Concrete Channels	Superstructure	LF	1-4	38
385	Reinforced Concrete Arch Spandrel Column	Superstructure	Each	1-4	38
387	Reinforced Concrete Wingwall	Substructure	Each	1-4	38
414	Reinforced Concrete Arch Spandrel Wall	Superstructure	LF	1-4	38

Mn/DOT Pontis Element List					
Element #	**Element Description**	**Element Type**	**Units**	**Rating Scale**	**Page**
Prestressed Concrete Elements					
104	Prestressed Concrete Box Girder	Superstructure	LF	1-4	39
109	Prestressed Concrete Girder or Beam	Superstructure	LF	1-4	39
115	Prestressed Concrete Stringer	Superstructure	LF	1-4	39
143	Prestressed Concrete Arch	Superstructure	LF	1-4	39
154	Prestressed Concrete Floorbeam	Substructure	LF	1-4	39
204	Prestressed Concrete Column	Substructure	Each	1-4	39
226	Prestressed Concrete Piling	Substructure	Each	1-4	39
233	Prestressed Concrete Pier Cap	Substructure	LF	1-4	39
374	Prestressed Concrete Double, Quad, Bulb, or Inverted Tees	Superstructure	LF	1-4	39
402	Prestressed Concrete Voided Slab Panels	Superstructure	LF	1-4	39
Timber Elements					
111	Timber Girder or Beam	Superstructure	LF	1-4	40
117	Timber Stringer	Superstructure	LF	1-4	40
135	Timber Arch or Truss	Superstructure	LF	1-4	40
156	Timber Floorbeam	Superstructure	LF	1-4	40
206	Timber Column	Substructure	Each	1-4	40
216	Timber Abutment	Substructure	LF	1-4	40
228	Timber Piling	Substructure	Each	1-4	40
235	Timber Pier Cap	Substructure	LF	1-4	40
386	Timber Wingwall	Substructure	Each	1-4	40
415	Timber Transverse Stiffener Beam (Timber Slabs)	Deck	LF	1-4	40
Masonry, Other, or Combination Material Elements					
145	Masonry, Other, or Combination Material Arch	Superstructure	LF	1-4	41
211	Masonry, Other, or Combination Material Pier Wall	Substructure	LF	1-4	41
217	Masonry, Other, or Combination Material Abutment	Substructure	LF	1-4	41
416	Masonry, Other, or Combination Material Pier Cap	Substructure	LF	1-4	41
417	Masonry, Other, or Combination Material Column	Substructure	Each	1-4	41
418	Masonry, Other, or Combination Material Wingwall	Substructure	Each	1-4	41
420	Masonry, Other, or Combination Material Arch Spandrel Wall	Superstructure	LF	1-4	41
Other Structural Elements					
310	Elastomeric (Expansion) Bearing	Superstructure	Each	1-3	44
311	Expansion Bearing	Superstructure	Each	1-3	45
312	Enclosed/Concealed Bearing	Superstructure	Each	1-3	46
313	Fixed Bearing	Superstructure	Each	1-3	46
314	Pot Bearing	Superstructure	Each	1-3	47
315	Disk Bearing	Superstructure	Each	1-3	47
160	Pin & Hanger (or Hinge Pin) Assembly - Unpainted	Superstructure	Each	1-4	48
161	Pin & Hanger (or Hinge Pin) Assembly - Painted	Superstructure	Each	1-5	48
373	Steel Hinge Assembly	Superstructure	Each	1-5	52
379	Concrete Hinge Assembly	Superstructure	Each	1-4	53
146	Steel Cable (Bare)	Superstructure	Each	1-4	54
147	Steel Cable (Coated or Encased)	Superstructure	Each	1-5	54
380	Secondary Structural Elements	Superstructure	Each	1-4	55
382	Cast-In-Place (CIP) Piling	Substructure	Each	1-4	56
381	Tunnel	Superstructure	LF	1-4	56
Culvert Elements					
240	Steel Culvert	Culvert	LF	1-4	60
241	Reinforced Concrete Culvert	Culvert	LF	1-4	60
242	Timber Culvert	Culvert	LF	1-4	61
243	Masonry, Other, or Combination Material Culvert	Culvert	LF	1-4	61
388	Culvert Wingwall, Headwall, or Other End Treatment	Culvert	Each	1-4	62
421	Culvert Footing	Culvert	LF	1-4	62

Mn/DOT Pontis Element List					
Element #	**Element Description**	**Element Type**	**Units**	**Rating Scale**	**Page**
Smart Flags					
356	Fatigue Cracking Smart Flag	Miscellaneous	Each	1-3	63
357	Pack Rust Smart Flag	Miscellaneous	Each	1-4	63
358	Concrete Deck Cracking Smart Flag	Miscellaneous	Each	1-4	64
359	Underside of Concrete Deck Smart Flag	Miscellaneous	Each	1-5	64
360	Substructure Settlement & Movement Smart Flag	Miscellaneous	Each	1-3	65
361	Scour Smart Flag	Miscellaneous	Each	1-3	65
362	Traffic Impact Smart Flag	Miscellaneous	Each	1-3	65
363	Section Loss Smart Flag	Miscellaneous	Each	1-4	66
964	Critical Finding Smart Flag	Miscellaneous	Each	1-2	66
965	Concrete Shear Cracking Smart Flag	Miscellaneous	Each	1-4	66
966	Fracture Critical Smart Flag	Miscellaneous	Each	1-3	67
Other Items					
981	Signing	Miscellaneous	Each	1-3	67
982	Approach Guardrail	Miscellaneous	Each	1-3	68
983	Plowstraps	Miscellaneous	Each	1-3	68
984	Deck & Approach Drainage	Miscellaneous	Each	1-3	68
985	Slopes & Slope Protection	Miscellaneous	Each	1-3	68
986	Curb & Sidewalk	Miscellaneous	Each	1-3	69
987	Roadway over Culvert	Miscellaneous	Each	1-3	69
988	Miscellaneous Items	Miscellaneous	Each	1-3	69

3.3 Pontis Deck & Slab Elements

This section includes Pontis element rating descriptions for decks, slabs, deck joints, bridge approaches, and bridge railings.

3.3.1 Rating Procedures for Concrete Decks & Slabs

Concrete deck (and slab) elements are selected based upon the wearing surface material (low slump concrete, bituminous, etc.), as well as the type of corrosion prevention system (such as epoxy coated reinforcement). In this manual, the condition rating descriptions for concrete deck and slab elements are divided into four groups…

- Section 3.3.2: Concrete decks & slabs without overlays
- Section 3.3.3: Concrete decks & slabs with low slump overlays
- Section 3.3.4: Concrete decks & slabs with latex or epoxy overlays
- Section 3.3.5: Concrete decks & slabs with bituminous overlays

All concrete deck and slab elements are rated on a scale of 1 to 5 (with 1 being "very good" condition and 5 being the worst condition). Although the quantity is displayed in square ft., the entire quantity must be rated as a single condition state. *Note: The condition ratings for concrete decks & slabs are based solely upon the condition of the wearing surface! Smart Flag element #359 (Underside of Deck/Slab) must be rated to describe the condition of the supporting concrete deck (or slab)!*

The condition ratings for concrete deck elements are based upon the percentage of unsound wearing surface (this item is displayed on the header of the Bridge Inspection Report). This quantity may be estimated from field observations, or calculated from a deck condition survey (such as chaining or ground penetrating radar). "Unsound" wearing surface includes areas with delamination, spalling, potholes, severe scale, or other significant deterioration. Temporary patches (such as those performed by maintenance personal) should be considered to be unsound. Long-term patches (such as those performed under a mill & patch contract) should not be considered to be unsound until these repaired areas have begun to deteriorate.

If the deck has a concrete wearing surface, Smart Flag element #358 (Deck Cracking) must also be rated. This smart flag is not required for decks with bituminous overlays (or if the wearing surface is covered in gravel).

The wearing surface type, depth, and year of installation should be displayed on the Mn/DOT Structure Inventory Report - if not, this information should be noted on the inspection report. The inspector should note any changes in the type or depth of the wearing surface - a new overlay may require a new deck element, and any increase in the wearing surface depth will require a new load rating.

While the presence of gravel is not a consideration when selecting deck elements, the gravel depth should be noted on the inspection report (excessive gravel may reduce the load rating). Concrete decks covered in gravel will typically be rated as condition "1" (as the top of the deck is not visible for inspection).

The deck protection system (and year of installation) should be displayed on the Mn/DOT Structure Inventory Report. Virtually all bridge decks constructed in Minnesota since 1980 have epoxy coated reinforcement - however, decks constructed in the early 1980's often had epoxy coated reinforcement on the top mat only (uncoated reinforcement was used on the lower mat). These bridge decks tend to have increased deterioration (rust staining and delamination) on the underside. Decks with bituminous overlays often have a waterproof membrane to protect the underlying deck - the plans may have to be reviewed to determine the proper deck element.

3.3.2 Concrete Decks & Slabs (Without Overlays)

These elements describe the condition of the top (wearing) surface on concrete decks (or slabs) that do not have an overlay. This can also include concrete decks (or slabs) covered with gravel. *Note: Smart Flag element #359 (Underside of Concrete Deck) must be also be rated to describe the condition of the supporting concrete deck (or slab)! Smart Flag element #358 (Deck Cracking) should also be rated.*

#12: Top of Concrete Deck with Uncoated Rebar (No Overlay)
#26: Top of Concrete Deck with Epoxy Rebar (No Overlay)
#27: Top of Concrete Deck (with Cathodic Protection System)
#38: Top of Concrete Slab with Uncoated Rebar (No Overlay)
#52: Top of Concrete Slab Epoxy Rebar (No Overlay)
#53: Top of Concrete Slab (with Cathodic Protection System)
#405: Top of Cast-in-Place Concrete Voided Slab (No Overlay)

Condition State 1: Top (wearing) surface of deck has no spalls, delaminations, or temporary patches.

Condition State 2: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is 2% or less of the total deck area.

Condition State 3: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is more than 2% but not more than 10% of the total deck area.

Condition State 4: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is more than 10% but not more than 25% of the total deck area.

Condition State 5: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is more than 25% of the total deck area.

3.3.3 Concrete Decks & Slabs (Low Slump Overlays)

These elements describe the condition of low slump concrete overlays on concrete decks (or slabs). *Note: Smart Flag element #359 (Underside of Concrete Deck) must be also be rated to describe the condition of the supporting concrete deck (or slab)! Smart Flag element #358 (Deck Cracking) must also be rated.*

#22: Low Slump Overlay (Concrete Deck with Uncoated Rebar)
#48: Low Slump Overlay (Concrete Slab with Uncoated Rebar)
#377: Low Slump Overlay (Concrete Deck with Epoxy Rebar)
#378: Low Slump Overlay (Concrete Slab with Epoxy Rebar)
#406: Low Slump Overlay (Cast-in-Place Concrete Voided Slab)

Condition State 1: Low slump overlay has no spalls, delaminations, or temporary patches.

Condition State 2: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is 2% or less of the total deck area.

Condition State 3: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is more than 2% but not more than 10% of the total deck area.

Condition State 4: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is more than 10% but not more than 25% of the total deck area.

Condition State 5: The combined area of distressed or unsound wearing surface (spalls, delaminations, patches, etc.) is more than 25% of the total deck area.

3.3.4 Concrete Decks & Slabs (Latex or Epoxy Overlays)

These elements describe the condition of latex, epoxy, or thin (less than 1") overlays on concrete decks (or slabs). Epoxy & Latex overlays were used sparingly in Minnesota in the 1970's & 1980's, but are now seldom used. *Note: Smart Flag element #359 (Underside of Deck or Slab) must be also be rated to describe the condition of the supporting concrete deck (or slab)!*

#18: Latex, Epoxy, or Thin Overlay (Concrete Deck)
#44: Latex, Epoxy, or Thin Overlay (Concrete Slab)

Condition State 1: Latex/Epoxy overlay has no spalls, delaminations, or patches.

Condition State 2: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is 2% or less of the total deck area.

Condition State 3: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is more than 2% but not more than 10% of the total deck area.

Condition State 4: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is more than 10% but not more than 25% of the total deck area.

Condition State 5: The combined area of unsound wearing surface (spalls, delaminations, temporary patches, etc.) is more than 25% of the total deck area.

3.3.5 Concrete Decks & Slabs (Bituminous Overlays)

These elements describe the condition of bituminous overlays on concrete decks (or slabs). The plans should be referenced to determine if there is a waterproof membrane below the overlay (the presence of epoxy-coated reinforcement is not a consideration with these elements). *Note: Smart Flag element #359 (Underside of Deck or Slab) must be also be rated to describe the condition of the supporting concrete deck (or slab)! Smart Flag Element #358 (Deck Cracking) should not be used for bituminous overlays.*

#13: Bituminous Overlay (Concrete Deck)
#14: Bituminous Overlay with Membrane (Concrete Deck)
#39: Bituminous Overlay (Concrete Slab)
#40: Bituminous Overlay with Membrane (Concrete Slab)

Condition State 1: Bituminous overlay has no potholes, spalls, or temporary patches.

Condition State 2: The combined area of unsound wearing surface (potholes, spalls, temporary patches, etc.) is 2% or less of the total deck area.

Condition State 3: The combined area of unsound wearing surface (potholes, spalls, temporary patches, etc.) is more than 2% but not more than 10% of the total deck area.

Condition State 4: The combined area of unsound wearing surface (potholes, spalls, temporary patches, etc.) is more than 10% but not more than 25% of the total deck area.

Condition State 5: The combined area of unsound wearing surface (potholes, spalls, temporary patches, etc.) is more than 25% of the total deck area.

3.3.6 Timber Decks & Slabs

These elements apply to timber decks or slabs - this includes timber, bituminous or gravel wearing surfaces. This includes timber plank decks, glue-lam deck panels, and nail laminated timber decks or slabs. All of these elements are an “each” item (the quantity will be displayed as the deck area in square ft.) - they are rated on a scale of 1-4 (the entire deck/slab area must be rated under a single condition state).

- **Element #31: Timber Deck (No Overlay)**
- **Element #32: Timber Deck with Bituminous (AC) Overlay**
- **Element #54: Timber Slab (No Overlay)**
- **Element #55: Timber Slab with Bituminous (AC) Overlay**

Timber plank decks are comprised of transverse timber planks (with the wide dimension in the horizontal plane). Timber plank decks often have longitudinal planks (“runners”) under each wheel track.

Nailed laminated timber decks consist of transverse timbers (with the wide dimension in the vertical position) that are nailed to the adjacent timbers. Nailed laminated decks often have a bituminous overlay.

Nail laminated timber slabs are similar to nail laminated decks, except the timbers are longitudinal, and serve as the primary superstructure element (the timbers are larger than those on a nail laminated deck). Timber slabs often have a bituminous wearing surface. *Note: timber slabs often have a transverse stiffener beam running below the slab near the center of the span - these beams can be rated using element #415.*

Glulam timber deck panels are typically 4 ft. wide and are typically installed transversely to the direction of traffic (these are often used for temporary bridges, and frequently have a bituminous overlay).

Condition State 1: Timber deck/slab has little or no deterioration. Timber components may have superficial weathering or splitting. All deck/slab components are properly orientated and solidly connected. Running planks (if present) are in good condition and soundly attached. Bituminous overlay (if present) is in good condition (no potholes).

Condition State 2: Timber deck/slab has minor to moderate deterioration. Timber components may have moderate weathering or splitting - there may be minor decay, crushing, or sagging. Deck/slab components may be slightly loose or misaligned. Running planks may be worn or slightly loose. Bituminous overlay may have moderate cracking - there may be some potholes.

Condition State 3: Timber deck/slab has extensive deterioration - repairs may be recommended, but the load-carrying capacity of the deck has not been significantly reduced. Timber components may have extensive weathering or splitting - there may be decay, crushing, or sagging. Deck/slab components may be missing, loose, or misaligned. Running planks may be misaligned (some sections may be missing). Bituminous overlay may have extensive cracking or potholes.

Condition State 4: Timber deck/slab has severe or critical deterioration. Full-depth failures may be present - immediate repairs may be necessary. Timber components may have severe decay, crushing, or sagging. Wearing surface may have failed.

3.3.7 Other Deck Types

- **Element #28: Steel Grid Deck - Open**
- **Element #29: Steel Grid Deck - Concrete Filled**

Element #28 applies to open grid steel deck, Element #29 refers to steel grid decks that have been fully or partially filled with concrete. Steel grid panels may be welded, riveted, or bolted - the top edges are often serrated to improve traction. Both of these elements are an “each” item (the quantity will be displayed as the deck area in square ft.) - they are rated on a scale of 1-5 (the entire deck area must be rated under a single condition state). *Note: The rating should take into consideration any deck support components that are not addressed by other Pontis elements.*

Condition State 1: Steel grid deck has little or no deterioration. The paint or galvanizing system (if present) remains sound - there is no notable corrosion. All deck supports and connections (welds, rivets, bolts, etc.) are in good condition. Concrete filler (if any) is in good condition.

Condition State 2: Steel grid deck has minor deterioration. Paint or galvanizing system (if present) may have some failure - surface corrosion may be present. Deck supports and connections may have minor deterioration, but remain sound. Concrete filler (if any) may have minor deterioration, but remains intact.

Condition State 3: Steel grid deck has moderate deterioration. Paint or galvanizing system (if present) may have moderate failure - surface corrosion may be prevalent, but any section loss is incidental. Deck supports and connections may have moderate deterioration or isolated failure (cracked welds or broken rivets), but the grid panels remain secure and in proper alignment. Concrete filler (if any) may have moderate deterioration - the concrete may have broken out in some locations.

Condition State 4: Steel grid deck has extensive deterioration. Paint or galvanizing system (if present) may have complete failure. There may be extensive surface corrosion or measurable section loss. Failure of support components and connections may have resulted in some grid panels coming slightly loose or out alignment. Concrete filler (if any) may have extensive deterioration - the concrete may have broken out in numerous locations.

Condition State 5: Steel grid deck has severe or deterioration - immediate repairs may be required. The steel grid panels may have severe section loss (areas may have rusted through). Failure of support components and connections may have resulted in some grid panels coming severely loose or out of alignment. Most of the concrete filler may be missing.

Element #30: Corrugated, Orthotropic, Exodermic, or Other Deck

This element applies corrugated decks, orthotropic decks, or any deck type not adequately described by the other deck elements. This element is an “each” item (the quantity will be displayed as the deck area in square ft.). This element is rated on a scale of 1-5 (the entire deck area must be rated under a single condition state).

Corrugated decks are typically comprised of corrugated steel forms (with concrete or bituminous fill), in which the steel forms provide the primary structural support.

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

An Exodermic deck is a recently developed modular design that combines a steel grid with a reinforced concrete deck (advantages include light weight and rapid construction). This design has only been used on a limited basis in Minnesota.

Condition State 1: Deck has little or no deterioration. Paint or galvanizing system (if present) remains sound - there is no notable corrosion. The wearing surface (or filler material) is sound, with no notable deterioration.

Condition State 2: Deck has minor deterioration. Paint or galvanizing system (if present) may have some failure - surface corrosion may be present. Wearing surface (or filler material) may have minor deterioration (cracking, spalling, or potholes).

Condition State 3: Deck has moderate deterioration. Paint or galvanizing system (if present) may have moderate failure - surface corrosion may be prevalent, but any section loss is incidental. Wearing surface (or filler material) may have moderate deterioration (cracking, spalling, or potholes) - but the underlying deck forms are not exposed.

Condition State 4: Deck has extensive deterioration. Paint or galvanizing system (if present) may have complete failure. There may be extensive surface corrosion or measurable section loss. Wearing surface (or filler material) may have extensive deterioration - the underlying deck may be exposed.

Condition State 5: Deck has severe deterioration - immediate repairs may be required. Steel deck components may have severe section loss (areas may have rusted through). Wearing surface (or filler material) may have severe deterioration - a significant portion of the underlying decking may be exposed.

Element #401: Steel Ballast Plate Deck (Railroad Bridges)

This element applies to steel ballast plate decks (commonly used on railroad bridges). These decks consist of steel plates attached directly to the superstructure (they are often connected with clips that allow the deck to expand independently from the superstructure). The steel ballast plate is typically covered with a waterproof membrane and rock ballast (the railroad ties are placed on the ballast). This element is an "each" item (the quantity will be displayed as the deck area in square ft.). This element is rated on a scale of 1-5 (the entire deck area must be rated under a single condition state). *Note: The inspector should note if the railroad tracks are active, abandoned, or removed.*

Condition State 1: Steel ballast plate deck has little or no deterioration. Paint system (if present) remains sound - there is no notable corrosion. There is no deck leakage. All ballast clips (or other deck connections) are secure. Rock ballast and wearing surface (if present) have no notable deterioration.

Condition State 2: Steel ballast plate deck has minor deterioration. Paint system (if present) may have some failure - surface corrosion may be present. There may be minor deck leakage. A small number of ballast clips (or other connections) may be loose or missing. Rock ballast and wearing surface (if present) may have minor deterioration.

Condition State 3: Steel ballast plate deck has moderate deterioration. Paint system (if present) may have moderate failure - surface corrosion may be prevalent, but any section loss is incidental. There may be moderate deck leakage. Several ballast clips (or other connections) may be loose or missing. Rock ballast and wearing surface (if present) may have moderate deterioration.

Condition State 4: Steel ballast plate deck has extensive deterioration. Paint system (if present) may have complete failure. There may be extensive surface corrosion or measurable section loss. There may be extensive deck leakage. A significant number of ballast clips (or other connections) may be loose or missing. Rock ballast and wearing surface (if present) may have extensive deterioration.

Condition State 5: Steel ballast plate railroad deck has severe deterioration - immediate repairs may be required. Steel deck components may have severe section loss (areas may have rusted through), or may be loose or out of alignment.

3.3.8 Deck Joints

Deck joint elements are rated on a scale of 1-3 - condition “3” typically indicates that joint repair or replacement is required. The quantity is listed as linear feet, measured along the full length of the expansion joint (this includes the roadway, as well as joints through railings, medians, and sidewalks). Deck joints should be inspected for leakage, as well as for proper function. Deck joints should be examined for skew, offset, or any evidence that the joint is restricted or is beyond the limits of expansion. *Note: deck expansion joints that are closed tightly, offset vertically or horizontally, or have large gaps may indicate severe structural problems (such as substructure movement).*

Element #300: Strip Seal Deck Joint

This element applies to deck joints that utilize a waterproof gland (typically a “V” shaped neoprene seal), held in place by a steel extrusion anchored to the bridge deck.

Condition State 1: Strip seal joint has little or no deterioration (no leakage). Gland is sound and securely anchored. Joint anchorage and adjacent deck remain sound and intact. Joint is properly aligned and functioning as intended. Debris in the joint (if any) is not causing any problems.

Condition State 2: Strip seal joint has moderate deterioration - minor leakage may be evident. Gland may be partially pulled out. Joint anchorage may be slightly damaged. Adjacent deck may have minor spalling. Joint may be slightly misaligned (skewed, offset, or near limits of expansion), but the function has not been significantly impaired. Debris in the joint may be causing problems.

Condition State 3: Strip seal joint has severe deterioration - there may be significant leakage. Gland may be punctured, torn, or pulled loose. The joint anchorage may be damaged or deteriorated to the extent that the gland can no longer be properly anchored. Adjacent deck may have severe spalling. Joint may be severely misaligned - the function may be significantly impaired.

Element #301: Poured Deck Joint

This element applies to deck joints filled with a poured or extruded sealant - this typically refers to saw & seal joints (above piers or along end blocks), but can also include bituminous plug joints or median joints.

Condition State 1: Poured joint has little or no deterioration (no leakage). Joint sealant is properly adhered. Adjacent deck is sound and intact.

Condition State 2: Poured joint has moderate deterioration - minor leakage may be evident. Joint sealant may have minor adhesion failures. Adjacent deck may have minor cracking or spalling.

Condition State 3: Poured joint has severe deterioration - there may be significant leakage. Joint sealant may have failed. Adjacent deck may have severe cracking or spalling.

Element #302: Compression Seal Deck Joint

This element applies to deck joints consisting of a pre-formed elastic compression seal - this includes seals with a solid or hollow cross-section. The joint may (or may not) include steel protection angles.

Condition State 1: Compression joint has little or no deterioration (no leakage). Compression seal is sound and securely anchored. Protection angles (if present) are in good condition. Adjacent deck remains sound and intact. Joint is properly aligned and functioning as intended. Debris in the joint (if any) is not causing any problems.

Condition State 2: Compression joint has moderate deterioration (minor leakage may be evident). Compression seal may be slightly loose or out of position. Protection angles may have minor damage. Adjacent deck may have minor spalling. Joint may be slightly misaligned (skewed, offset, or near limits

of expansion), but the function has not been significantly impaired. Debris in the joint may be causing problems.

Condition State 3: Compression joint has severe deterioration (there may be significant leakage). Compression seal may be punctured, torn, or out of position. Protection angles may have severe damage. Adjacent deck may have severe spalling. Joint may be severely misaligned - joint function may be significantly impaired.

Element #303: Assembly Deck Joint (with or without seal)

This element applies to deck joints consisting of an assembly mechanism (with or without a seal). This includes deck joints comprised of sliding steel plates, anchored rubber seals, or any joint that is not adequately described by the other deck joint elements.

Condition State 1: Assembly joint has little or no deterioration. If the joint is sealed, there is no leakage. All joint components are sound and securely anchored. Steel components have little or no corrosion. Adjacent deck remains sound and intact. Joint is properly aligned and functioning as intended. Debris in the joint (if any) is not causing any problems.

Condition State 2: Assembly joint has moderate deterioration. If the joint is sealed, minor leakage may be evident. Joint components may be loose. Steel components may have moderate corrosion and/or section loss. Adjacent deck may have minor spalling. Joint may be slightly misaligned (skewed, offset, or near limits of expansion), but the function has not been significantly impaired. Debris in the joint may be causing problems.

Condition State 3: Assembly joint has severe deterioration. Seals may have failed. Joint components may be missing. Steel components may have severe section loss. Adjacent deck may have severe spalling. Joint may be severely misaligned - joint function may be significantly impaired.

Element #304: Open Deck Joint

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

Condition State 1: Open joint has little or no deterioration. Protection angles (if present) are sound and securely anchored. Adjacent deck is sound. Joint is properly aligned and functioning as intended.

Condition State 2: Open joint has moderate deterioration. Protection angles may have moderate corrosion damage or may have started to loosen - some anchor bolts may be loose, broken or missing. Adjacent deck may have minor spalling. Joint may be slightly misaligned (skewed, offset, or near limits of expansion), but the function not been significantly impaired.

Condition State 3: Open joint has severe deterioration. Protection angles may be severely damaged or missing. Adjacent deck may have severe spalling. Joint may be severely misaligned - joint function may be significantly impaired.

Element #410: Modular Deck Joint

This element applies to “Modular” deck joints. Modular deck joints are comprised of two or more adjacent waterproof seals (“V” strip or compression seal). The seals are typically anchored by steel extrusions cast into the deck, and supported from below by small beams (which often have an independent expansion bearing system). Modular joints typically incorporate equalizer springs and guide systems to keep the seals equally spaced and properly aligned.

Condition State 1: Modular joint has little or no deterioration (no leakage). Seals are sound and securely anchored. All joint components (extrusion/joint anchorage, support beams, equalizers, and guide systems) are sound and intact. Adjacent deck is sound. Joint is properly aligned and functioning as intended. Debris in the joint (if any) is not causing any problems.

Condition State 2: Modular joint has moderate deterioration - minor leakage may be evident. Seals may be partially pulled out, slightly loose or out of position. Joint equalizers (or guide system components) may be loose, damaged or missing. Joint support beams remain sound and intact. The joint anchorage may be slightly damaged. Adjacent deck may have minor spalling. Joint may be slightly misaligned (skewed, offset, or near limits of expansion), but the function has not been significantly impaired. Debris in the joint may be causing problems.

Condition State 3: Modular joint has severe deterioration - there may be significant leakage. Seals may be punctured, torn, pulled loose, or out of position. Joint equalizer/guide system may be severely deteriorated or no longer functioning. Support beams may be loose, jammed, or otherwise inoperative. Joint anchorage may be damaged or deteriorated to the extent that the gland can no longer be properly attached. Adjacent deck may have severe spalling. Joint may be severely misaligned - joint function may be significantly impaired.

Element #411: Finger Plate Deck Joint

This element applies to finger plate deck joints (two steel plates with interlocking “fingers”).

Condition State 1: Finger plate joint has little or no deterioration. Expansion plates are securely anchored (all fingers are intact). Adjacent deck is sound. Joint is properly aligned and functioning as intended.

Condition State 2: Finger plate joint has moderate deterioration. Some fingers may be broken off. Expansion plates may have started to loosen - some anchor bolts may be loose, broken or missing (welds may have broken). Adjacent deck may have minor spalling. Joint may be slightly misaligned (skewed, offset, or near limits of expansion), but the function has not been significantly impaired.

Condition State 3: Finger plate joint has severe deterioration. A significant number of fingers may be broken off. Expansion plates may be loose or missing - a large number of anchor bolts may be loose, broken or missing. Adjacent deck may have severe spalling. Joint may be severely misaligned - joint function may be significantly impaired.

Element #412: Approach Relief Joint

This element applies to approach slab relief joints. They are used when a concrete approach slab meets an adjacent concrete roadway, and are designed to accommodate expansion of the roadway). A typical relief joint is 4” wide and consists of preformed polystyrene filler with a hot poured seal.

Condition State 1: Approach relief joint has little or no deterioration. Joint seal and filler remain intact. Joint has not closed significantly. The adjacent roadway and approach are in good condition.

Condition State 2: Approach relief joint has moderate deterioration. Joint seal and/or filler material may be missing - the joint may be filled with debris. Joint may be partially closed, but can still accommodate additional expansion. Adjacent roadway or approach may have minor spalling.

Condition State 3: Approach relief joint has severe deterioration - repair or replacement may be required. Joint may be closed (or nearly closed), with no room for additional expansion. Adjacent roadway or approach may have severe spalling.

3.3.9 Roadway Approach Elements

These elements apply to approach slabs and the roadway approaches to the bridge. These elements are only intended to rate the condition of the approach - geometric problems should be addressed using the Approach Roadway Alignment Appraisal Rating (FHWA Item #72). These elements are “each” items (rated on a scale of 1-4). The quantity will typically be “2” (one for each end of the bridge) - they can be rated under separate condition states. If the bridge has a divided median or ramp, the quantity can be increased to rate each panel separately.

- **Element #320: Concrete Approach Slab (Bituminous Wearing Surface)**
- **Element #321: Concrete Approach Slab (Concrete Wearing Surface)**
- **Element #407: Bituminous Approach Roadway**
- **Element #408: Gravel Approach Roadway**

Note: an “approach slab” is a short concrete paving segment between the end of the bridge and the approach roadway (usually supported by the abutment parapet at the bridge end, and a concrete sill at the roadway end). If approach slabs are not present, the “approach roadway” elements can be used (this typically includes the approach roadway extending approximately 20 ft. from the end of the bridge).

Condition State 1: Approach has little or no deterioration. There is no settlement or undermining - the ride transitions smoothly on/off the bridge deck. Concrete approaches may have superficial cracking or wear - there are no delaminations or spalls. Bituminous approaches are smooth and even - there are no potholes. Gravel approaches are evenly graded.

Condition State 2: Approach has minor to moderate deterioration. There may be slight settlement or undermining, but traffic impact on the bridge has not been significantly increased. Concrete approaches may have moderate cracking, scaling, or wear - there may be minor delamination or spalling. Bituminous approaches may have moderate cracking, or may be slightly uneven - potholes may be present. Gravel approaches may be moderately rutted or eroded.

Condition State 3: Approach has extensive deterioration - repairs may be required. Settlement or undermining may have significantly increased traffic impact on the bridge. Concrete approaches may have extensive scaling or cracking (cracking may extend through the underlying slab) - there may be significant delamination or spalling. Bituminous approaches may have extensive cracking or potholes - or may be uneven. Gravel approaches may have extensive rutting or erosion.

Condition State 4: Approach has severe or critical deterioration - immediate repairs may be required. Settlement or undermining may have severely increased traffic impact on the bridge. Deterioration of the wearing surface may be severe enough to present a traffic hazard.

3.3.10 Bridge Railing Elements

Select the railing element that best describes the railing present on the bridge (some bridges have more than one railing type). Railing elements are “linear feet” quantities (the rating scale varies). The quantity is measured along the length of the railing, and can include railing on the wingwalls or approaches.

Element #330: Metal Bridge Railing (Uncoated or Unpainted)

This element applies to metal railings that are not (and have never been) coated or painted.

Condition State 1: Uncoated metal railing has little or no deterioration. There may be minor surface corrosion, but there is no section loss. Railing may have superficial impact damage.

Condition State 2: Uncoated metal railing has minor to moderate deterioration or impact damage. There may be surface corrosion (minor section loss). Components may be slightly bent or misaligned.

Condition State 3: Uncoated metal railing has extensive deterioration or impact damage. There may be extensive surface corrosion or section loss. Connections or anchorages may be slightly loose - components may be bent or misaligned.

Condition State 4: Uncoated metal railing has severe deterioration or impact damage - immediate repairs may be required. There may be advanced corrosion or significant section loss. Connections or anchorages may have failed - components may be severed, torn loose, or missing.

Element #331: Reinforced Concrete Bridge Railing

This element applies to reinforced concrete railings (of any type or shape).

Condition State 1: Concrete railing has little or no deterioration. There may be superficial cracking, scaling, pop-outs, leaching, or staining. There may be superficial impact damage.

Condition State 2: Concrete railing has minor to moderate deterioration or impact damage. There may be minor cracking, scaling, leaching, or staining. There may be minor delamination or spalling.

Condition State 3: Concrete railing has extensive deterioration or impact damage. There may be extensive cracking, scaling, leaching, staining, delamination or spalling (with exposed rebar).

Condition State 4: Concrete railing has severe deterioration or impact damage - immediate repairs may be required. There may be severe cracking, scaling, delamination or spalling (with exposed rebar).

Element #332: Timber Bridge Railing

This element applies to bridge railings comprised primarily or entirely of timber.

Condition State 1: Timber railing has minor deterioration or impact damage. There may be minor weathering or cracking - but there is no decay or structural distress (crushing or sagging). All connections are sound and intact - all components are properly aligned.

Condition State 2: Timber railing has moderate deterioration or impact damage. There may be extensive weathering or cracking - there may be some decay or structural distress (minor crushing or sagging). Connections may be slightly loose - components may be slightly misaligned.

Condition State 3: Timber railing has severe deterioration or impact damage - immediate repairs may be required. There may be severe decay, crushing, or sagging (significant loss of cross-sectional area). Connections may have failed - components may be severely damaged or torn loose.

Element #333: Masonry, Other, or Combination Material Railing

This element applies to railings constructed of any combination of materials (concrete, steel, aluminum, timber, etc.), or any railing that cannot be adequately described by the other railing elements.

Condition State 1: Railing has minor deterioration or impact damage. Concrete may have minor cracking, scaling, or leaching. Steel may have minor surface corrosion - paint/coating system (if present) may have minor deterioration. Timber may have minor weathering or cracking. All connections and anchorages are sound and intact - all components are properly aligned.

Condition State 2: Railing has moderate deterioration or impact damage. Concrete may have moderate cracking, scaling, leaching, or spalling (exposed rebar). Steel may have moderate corrosion (some section loss) - paint/coating system may have extensive failure. Timber may have extensive weathering or cracking - there may be decay, crushing, or sagging. Connections or anchorages may be slightly loose - components may be slightly bent or misaligned.

Condition State 3: Railing has severe deterioration or impact damage - immediate repairs may be required. Concrete may have severe cracking or spalling (exposed rebar). Steel may have severe corrosion or section loss. Timber may have severe decay, crushing, or sagging. Connections or anchorages may have failed - components may be severely bent, severed, fractured, or torn loose.

Element #334: Metal Bridge Railing (Coated or Painted)

This element applies to metal railings that have been painted, galvanized or otherwise coated.

Condition State 1: Coating metal railing has little or no deterioration (no corrosion or impact damage).

Condition State 2: Coating metal railing has minor deterioration or impact damage. There may be minor surface corrosion (no section loss). Connections and anchorages are sound and intact.

Condition State 3: Coating metal railing has moderate deterioration or impact damage. Surface corrosion may be prevalent (minor section loss). Connections or anchorages may be slightly loose - components may be slightly bent or misaligned.

Condition State 4: Coating metal railing has extensive deterioration or impact damage. There may be extensive corrosion (measurable section loss). Connections or anchorages may be loose - components may be bent or misaligned.

Condition State 5: Coated metal railing severe deterioration or impact damage - immediate repairs may be required. There may be severe section loss. Connections or anchorages may have failed - components may be severed, torn loose, or missing.

Element #409: Chain Link Fence

Condition State 1: Chain link fence has little or no deterioration. Galvanizing or vinyl coating is sound.

Condition State 2: Chain link fence has minor deterioration. Coating may have minor failure - surface rust may be present. Fence components are properly aligned (all connections are sound).

Condition State 3: Chain link fence has moderate deterioration. Coating may have moderate failure - surface rust may be prevalent. Components may be slightly bent or misaligned - connections may be slightly loose. Fence fabric may have snags or holes (areas may be slightly stretched or deformed).

Condition State 4: Chain link fence has extensive deterioration. Coating may have extensive failure - there may be section loss. Components may be bent or misaligned - connections may be loose. Fence fabric may have numerous snags or holes (areas may be stretched or deformed).

Condition State 5: Chain link fence has severe deterioration - immediate repairs may be required. Components may be loose, missing, or severely bent. Fence fabric may be loose or missing.

3.4 Pontis Structural Elements (Grouped by Material Type)

This section includes rating descriptions for Pontis structural elements (mainly superstructure and substructure). The elements are grouped by material type (painted steel, unpainted weathering steel, reinforced concrete, pre-stressed concrete, timber, or masonry/other material).

3.4.1 Painted Steel Elements

These elements apply to structural steel members that have been painted (even if the paint system has completely failed).

- **Element #102: Painted Steel Box Girder (LF)**
- **Element #107: Painted Steel Girder or Beam (LF)**
- **Element #113: Painted Steel Stringer (LF)**
- **Element #121: Painted Steel Through Truss - Bottom Chord (LF)**
- **Element #126: Painted Steel Through Truss - Upper Members (LF)**
- **Element #131: Painted Steel Deck Truss (LF)**
- **Element #141: Painted Steel Arch (LF)**
- **Element #152: Painted Steel Floorbeam (LF)**
- **Element #202: Painted Steel Column (EA)**
- **Element #231: Painted Steel Pier Cap (LF)**
- **Element #384: Painted Steel Arch Spandrel Column (EA)**
- **Element #419: Painted Steel Piling (EA)**

Condition State 1: Painted steel element has little or no deterioration. The paint system may have minor fading, salt film, or chalking, but there is no corrosion. There is no section loss (this includes repainted areas).

Condition State 2: Painted steel element has minor deterioration. The paint system may have moderate deterioration (chalking, peeling, blistering or other distress), but any exposed steel is limited. Surface corrosion (freckled rust) may be present, but there is no flaking rust. Repainted areas may have minor section loss. All connections are sound - element is in proper position and alignment. *Note: elements that have been repaired or reinforced should generally not be rated above Condition 2.*

Condition State 3: Painted steel element has moderate deterioration. The paint system may have extensive deterioration. Surface corrosion (freckled rust) may be prevalent - there may be isolated flaking rust (with minor section loss). Repainted elements may have measurable section loss in non-critical locations. Connections may have minor distress - element may be slightly out of alignment.

Condition State 4: Painted steel element has extensive deterioration - repairs may be required, but the load-carrying capacity of the element has not been significantly reduced. There may be severe corrosion, with extensive flaking rust. While there may be significant section loss, structural analysis is not yet required (section loss is less than 10% of the effective section). Connections may have started to come loose - element may be out of proper position or alignment.

Condition State 5: Painted steel element has severe or critical deterioration. The load-carrying capacity has been significantly reduced - structural analysis or immediate repairs may be required. Section loss may exceed 10% of the effective section. There may be severe impact damage. Element may be severely damaged, severed, or severely out of alignment. Connections may have failed.

3.4.2 Weathering Steel Elements

These elements apply only to structural members constructed of weathering steel (such as Mn/DOT Spec. #3309). This includes weathering steel members that have been left unpainted, as well as weathering steel members that have been partially or completely painted. *Note: bridges constructed of unpainted weathering steel are usually painted in "high corrosion areas" (on a steel beam bridge, this typically includes the area within 7 ft. of a deck joint). Paint failure outside the "high corrosion" areas should be considered to be an aesthetic issue, and should not reduce the condition rating.*

- **Element #101: Weathering Steel Box Girder (LF)**
- **Element #106: Weathering Steel Girder or Beam (LF)**
- **Element #112: Weathering Steel Stringer (LF)**
- **Element #120: Weathering Steel Through Truss - Bottom Chord (LF)**
- **Element #125: Weathering Steel Through Truss - Upper Members (LF)**
- **Element #130: Weathering Steel Deck Truss (LF)**
- **Element #140: Weathering Steel Arch (LF)**
- **Element #151: Weathering Steel Floorbeam (LF)**
- **Element #201: Weathering Steel Column (EA)**
- **Element #225: Weathering Steel Piling (EA)**
- **Element #230: Weathering Steel Pier Cap (LF)**
- **Element #413: Weathering Steel Arch Spandrel Column (EA)**

Condition State 1: Weathering steel element has little or no deterioration. The protective oxide coating is uniform and tightly adhered. Corrosion has not progressed beyond the intended layer of surface rust - there is no notable section loss. Painted areas "high corrosion areas" (if any) have little or no deterioration.

Condition State 2: Weathering steel element has minor to moderate deterioration. The protective oxide coating has partially failed - the surface may be dusty or granular. While corrosion may have progressed beyond the surface layer, any section loss is incidental. Painted "high corrosion areas" (if any) may have minor to moderate deterioration. Element is in proper position and alignment - all connections are sound. *Note: elements that have been repaired or reinforced should generally not be rated above Condition State 2.*

Condition State 3: Weathering steel element has extensive deterioration, but the load-carrying capacity of the member has not been significantly reduced. The protective oxide coating has extensive failure - the surface may be flaking off. There may be extensive corrosion. While there may be significant section loss, structural analysis is not yet required (section loss is less than 10% of the effective section). Painted "high corrosion areas" (if any) may have extensive or complete failure. Element may be slightly out of position or alignment - connections may have started to come loose.

Condition State 4: Weathering steel element has severe or critical deterioration. The load-carrying capacity of the member has been significantly reduced - structural analysis or immediate repairs may be required. The protective oxide coating has failed. Section loss may exceed 10% of the effective section. The element may be severely damaged or significantly out of position or alignment - connections may have failed.

3.4.3 Reinforced Concrete Elements

These elements apply to structural members constructed of cast-in-place or pre-cast reinforced concrete (not pre-stressed or post-tensioned concrete).

- **Element #105: Reinforced Concrete Box Girder (LF)**
- **Element #110: Reinforced Concrete Girder or Beam (LF)**
- **Element #116: Reinforced Concrete Stringer (LF)**
- **Element #144: Reinforced Concrete Arch (LF)**
- **Element #155: Reinforced Concrete Floorbeam (LF)**
- **Element #205: Reinforced Concrete Column (EA)**
- **Element #210: Reinforced Concrete Pier Wall (LF)**
- **Element #215: Reinforced Concrete Abutment (LF)**
- **Element #220: Reinforced Concrete Footing (EA)**
- **Element #227: Reinforced Concrete Piling (EA)**
- **Element #234: Reinforced Concrete Pier Cap (LF)**
- **Element #375: Pre-cast Concrete Channels (LF)**
- **Element #385: Reinforced Concrete Arch Spandrel Column (EA)**
- **Element #387: Reinforced Concrete Wingwall (EA)**
- **Element #414: Reinforced Concrete Arch Spandrel Wall (LF)**

Condition State 1: Reinforced concrete element has little or no deterioration. There may be superficial cracking, leaching, staining, or surface scale - there is no notable delamination or spalling. The member has no impact damage or repair patches.

Condition State 2: Reinforced concrete element has minor to moderate deterioration. There may be moderate cracking, leaching, staining, or surface scale. Minor delaminations or spalls may be present, but there is little or no exposure of steel reinforcement. Element is in proper position and alignment - all connections are sound. Repair patches (if any) remain sound. *Note: elements that have been repaired or reinforced should generally not be rated above Condition 2.*

Condition State 3: Reinforced concrete element has extensive deterioration, but the load-carrying capacity of the element has not been significantly reduced. There may be extensive cracking, leaching, staining, or scale. Structural cracking (from shear or flexure) may be present. Delaminations and spalls may be prevalent. Exposed reinforcement may have corrosion, but any section loss is incidental and does not significantly affect the strength and/or serviceability of either the element or the bridge. Element may be slightly out of position or alignment - connections may have started to come loose.

Condition State 4: Reinforced concrete element has severe or critical deterioration. The load-carrying capacity of the element has been significantly reduced - structural analysis or immediate repairs may be required. Severe structural cracking (from shear or flexure) may be present. Spalling may be extensive or severe - exposed reinforcement may have significant section loss. The element may be severely damaged or significantly out of position or alignment - connections may have failed.

3.4.4 Prestressed Concrete Elements

These elements apply to structural members constructed of either prestressed or post-tensioned concrete.

- **Element #104: Prestressed Concrete Box Girder (LF)**
- **Element #109: Prestressed Concrete Girder or Beam (LF)**
- **Element #115: Prestressed Concrete Stringer (LF)**
- **Element #143: Prestressed Concrete Arch (LF)**
- **Element #154: Prestressed Concrete Floorbeam (LF)**
- **Element #204: Prestressed Concrete Column (EA)**
- **Element #226: Prestressed Concrete Piling (EA)**
- **Element #233: Prestressed Concrete Pier Cap (LF)**
- **Element #374: Prestressed Concrete Double, Quad, Bulb, or Inverted Tees (LF)**
- **Element #402: Prestressed Concrete Voided Slab Panels (LF)**

In a properly designed pre-stressed member, structural cracking (flexure or shear) should not develop under normal service loads. On pre-stressed concrete members, all cracks are significant - they should be measured and documented. Cracks provide openings for water and chlorides, which can lead to stress corrosion - the inspector should note any rust stains that may indicate corrosion of the pre-stressing strands.

Condition State 1: Pre-stressed concrete element has little or no deterioration. There is no notable cracking, staining, delamination or spalling. The member has no impact damage or repair patches.

Condition State 2: Pre-stressed concrete element has minor deterioration. There may be minor (non-structural) cracking, leaching, staining, or surface scale. There is no structural cracking (from shear or flexure). Minor delaminations or spalls may be present, but there is no exposure of the tensioning steel. Element is in proper position and alignment - all connections are sound. Repair patches (if any) remain sound. *Note: elements that have been repaired or reinforced should generally not be rated above Condition 2.*

Condition State 3: Pre-stressed concrete element has moderate deterioration, but the load-carrying capacity of the element has not been significantly reduced. There may be moderate cracking, leaching, staining, or scale. Structural cracking (from shear or flexure) may be present. Delaminations and spalls may be present. While the tensioning steel may be exposed, any section loss is incidental and does not significantly affect the strength and/or serviceability of either the element or the bridge. Element may be slightly out of position or alignment - connections may have started to come loose.

Condition State 4: Pre-stressed concrete element has severe or critical deterioration. The load-carrying capacity of the element has been significantly reduced - structural analysis or immediate repairs may be required. Severe structural cracking (from shear or flexure) may be present. Spalling may be extensive or severe - exposed tensioning steel may have significant section loss. The element may be severely damaged or significantly out of position or alignment - connections may have failed.

3.4.5 Timber Elements

These elements apply to timber structural members of any type - this includes sawn, glue-lam, or stress-laminated timber members.

- **Element #111: Timber Girder or Beam (LF)**
- **Element #117: Timber Stringer (LF)**
- **Element #135: Timber Truss or Arch (LF)**
- **Element #156: Timber Floorbeam (LF)**
- **Element #206: Timber Column (EA)**
- **Element #216: Timber Abutment (LF)**
- **Element #228: Timber Piling (EA)**
- **Element #235: Timber Pier Cap (LF)**
- **Element #386: Timber Wingwall (EA)**
- **Element #415: Timber Transverse Stiffener Beam - Timber Slab Spans (LF)**

Condition State 1: Timber element has little or no deterioration. There may be superficial cracks, splits, or checks. There is no decay, fire damage, or structural distress (crushing or sagging). There is no impact damage.

Condition State 2: Timber element has minor to moderate deterioration. There may be moderate cracking or splitting. There may be minor decay or fire damage, but there is no significant structural distress (crushing, or sagging). Element is in proper position and alignment - all connections are sound. Repaired/reinforced areas (if any) remain sound. *Note: elements that have been repaired or reinforced should generally not be rated above Condition 2.*

Condition State 3: Timber element has extensive deterioration - repairs may be required, but the load-carrying capacity has not been significantly reduced. There may be extensive cracking or splitting. Decay, infestation, or fire damage may have resulted in a slight reduction of cross-sectional area. There may be slight crushing or sagging. Element may be slightly out of position or alignment - connections may have started to come loose.

Condition State 4: Timber element has severe or critical deterioration (significant loss of cross-sectional area). The load-carrying capacity of the element has been significantly reduced - structural analysis or immediate repairs may be required. Timber element may have severe cracking or structural failure. There may be advanced decay, infestation, or fire damage. There may be severe crushing or sagging. The element may be severely damaged or significantly out of position or alignment - connections may have failed.

3.4.6 Masonry, Other, or Combination Material Elements

These elements apply to masonry of any type, shape, or configuration. These elements can also apply to structural elements constructed of any material (or combination of materials) not adequately described by the other elements. *Note: masonry arches with spans of less than 20 ft. can be rated using Pontis Element #243 (Masonry or Other Material Culvert).*

- **Element #145: Masonry, Other, or Combination Material Arch (LF)**
- **Element #211: Masonry, Other, or Combination Material Pier Wall (LF)**
- **Element #217: Masonry, Other, or Combination Material Abutment (LF)**
- **Element #416: Masonry, Other, or Combination Material Pier Cap (LF)**
- **Element #417: Masonry, Other, or Combination Material Column (EA)**
- **Element #418: Masonry, Other, or Combination Material Wingwall (EA)**
- **Element #420: Masonry, Other, or Combination Material Arch Spandrel Wall (LF)**

Condition State 1: Element has little or no deterioration - there may be superficial defects or staining. Masonry may have minor weathering - masonry blocks are properly aligned (mortar joints are sound) Timber may have minor cracks or splits. Concrete may have minor cracking or scale. Steel has little or no corrosion. Protective coatings (if any) remain sound.

Condition State 2: Element has minor to moderate deterioration (no repairs are necessary). Masonry may have moderate weathering (cracking or spalling may be evident). Masonry blocks may be slightly misaligned. Mortar joints may have minor deterioration (leakage or weed intrusion may be evident). Timber may have moderate splitting, decay or fire damage, but there is no crushing or sagging. Concrete may have moderate cracking, scaling, leaching, or staining - there may be some delamination or spalling. Steel may have moderate corrosion (little or no section loss). Protective coatings may have minor to moderate failure. Repaired/reinforced areas (if any) remain sound. *Note: elements that have been repaired or reinforced should typically not be rated above Condition State 2.*

Condition State 3: Element has extensive deterioration - repairs may be required, but the load-carrying capacity of the element has not been significantly reduced. Masonry may have extensive weathering, cracking, or spalling. Masonry blocks may significantly misaligned (offset, tipped, or settled). Mortar joints may have significant deterioration (extensive leakage or weed intrusion). Timber may have extensive cracking or splitting, significant decay or fire damage, or slight crushing or sagging. Concrete may have extensive cracking, scaling, leaching, or rust/water staining. Delamination and spalling may be prevalent (exposed reinforcement may have section loss). Steel components may have extensive corrosion (significant section loss). Protective coatings may have extensive or complete failure.

Condition State 4: Element has severe damage or deterioration. The load-carrying capacity of the element has been significantly reduced - structural analysis or immediate repairs may be required. Masonry may have severe weathering, cracking, or spalling. Masonry blocks may be severely misaligned (offset, tipped, or settled). Concrete may have severe structural cracking or spalling. Timber may have severe structural decay (significant loss of cross-sectional area), cracking, sagging, or crushing. Steel components may have severe section loss.

3.5 Other Pontis Structural Elements

This section includes ratings descriptions for Pontis elements that could not be adequately described by the material groupings (Section 3.4). This includes bridge elements (bearings, pin & hanger assemblies, and hinge bearings) where the condition descriptions emphasize proper function, as well as elements for steel cables, tunnels, cast-in-place piling, and secondary members.

3.5.1 Bearings

There are six bearing elements - they are all rated on a scale of 1-3, and are listed as an "each" quantity (the plans may need to be referenced to determine the type and quantity of bearing elements).

- **Element #310 - Elastomeric (Expansion) Bearings**
- **Element #311 - Expansion Bearings**
- **Element #312 - Enclosed or Concealed Bearings**
- **Element #313 - Fixed Bearings**
- **Element #314 - Pot Bearings**
- **Element #315 - Disk 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. 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 are designed to restrict lateral movement 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.

Bearings can also be designed to resist uplift or seismic forces. Restraining bearings prevent uplift of the superstructure - uplift forces may be present on curved bridges, anchor spans, steel pier caps, or on short end spans of continuous bridges. An uplift restraint system typically consists of tension members (such as anchor bolts or eyebars), and may incorporate a counterweight. Isolation bearings protect the superstructure from seismic forces - as Minnesota is considered to be at low risk for seismic activity, seismic isolation bearings are not required.

A bearing assembly typically consists of the following components…

- **Sole Plate:** The sole plate protects the superstructure member, and transfers load from the superstructure to the bearing.

- **Bearing:** 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.

- **Anchorage:** Bearings that resist longitudinal or lateral movement (or uplift forces) require an anchorage system - this typically consists of steel rods drilled (or cast) into the substructure unit.

Thermal Expansion & Contraction: The magnitude of longitudinal movement is dependant upon three factors - the coefficient of thermal expansion (steel and concrete are similar), the temperature range, and the contributing structure length. As the temperature in Minnesota may range from -30 degrees F up to 110 Degrees F, this works out to be around 1-1/8" for every 100 ft. of structure length.

In Minnesota, expansion bearing are designed to be in the neutral (centered) position at approximately 40 degrees F. Measurements should typically be referenced to this neutral alignment - measurements should be taken to the nearest 1/8", and the temperature at the time of the measurement should be recorded.

Inspection of Bridge Bearings: The importance of inspecting and properly maintaining bridge bearings should not be underestimated - seemingly minor bearing problems can become worse if ignored, eventually resulting in serious problems for the bridge.

- Bearing malfunction or misalignment can damage adjacent deck, superstructure, or substructure elements.
- Loss of bearing area (or anchorage failure) can result in collapse of a span.
- Severe bearing misalignment may indicate significant problems elsewhere on the bridge (such as substructure settlement or tipping).

The most common bearing malfunction is the seizing (or "freezing") of expansion bearings 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 of the bearing. Sliding plate, roller, and rocker bearings provide numerous locations for debris and moisture to collect. Expansion bearings should be examined for any obvious visual evidence of recent movement (such as scraped paint, wear, or fretting rust). If none is present, the inspector should take bearing measurements, or examine adjacent bridge 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.

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.

Expansion bearings are typically restrained from lateral movement by guide tabs, keeper bars, pintles, or pin caps. Guide tabs should be examined for binding (particularly on skewed or curved bridges). Keeper bars on roller bearings can seize due to corrosion or debris (failure of keeper bars can result in roller misalignment). Pintles can shear off (an exposed pintle may indicate excessive longitudinal movement).

Note: Lateral restraint is sometimes provided by shear keys (or shear lugs) that are separate from the bridge bearings (these are often incorporated with the end diaphragms). As there is not yet a specific Pontis element for these items, they can be rated using Element #380 (Secondary Structural Elements).

Uplift restraint devices typically incorporate tension members (such as eyebars or threaded rods) - they should be examined for section loss, cracking, binding, or connection failure.

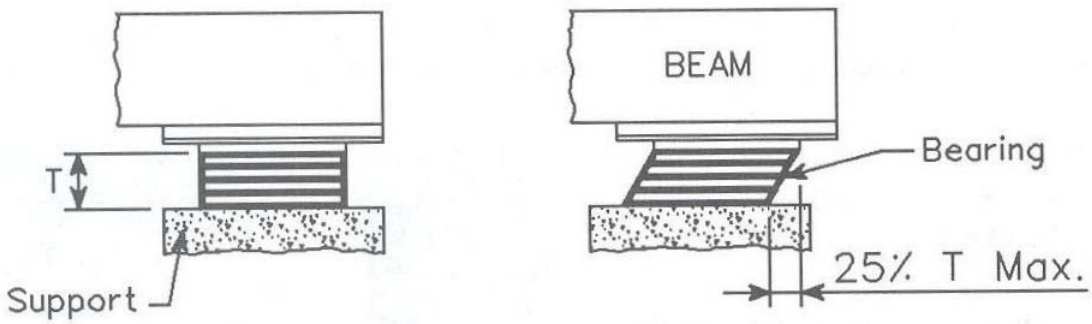
The bearing seat and anchorage should be examined for any deterioration or distress. Cracking or spalling of the bearing seat may indicate bearing failure - deterioration of the bearing seat can eventually result in loss of bearing area. Anchor bolts that are bent (or contacting the ends of slotted plates) may indicate excessive expansion or substructure movement. As only the upper portion of anchor bolts are visible for inspection, nondestructive testing may be necessary.

Element #310 - Elastomeric (Expansion) Bearings

This element applies to rectangular elastomeric bearing pads that facilitate expansion via deformation. Mn/DOT spec. #3741 covers elastomeric bearing pads - they are comprised of alternating layers of elastomer (100% virgin chloroprene) and 1/8” thick steel plates, which are bonded together. Older bridges may have solid (non-reinforced) pads, or pads laminated with fiberglass plates.

A curved steel pintle plate is usually placed on top of the pad to allow rotation due to deflection (in some cases this is vulcanized to the pad). Elastomeric expansion bearings may be restrained against lateral movement or uplift forces.

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 splitting, tearing, delamination, or excessive bulging. 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 orientation also depends upon the temperature when the bearing was installed. As elastomeric pads have a tendency to “walk” out from beneath the sole plate, any movement or misalignment should be noted.



Condition State 1: Elastomeric expansion bearing is in good condition and is functioning as intended. The bearing pad is properly positioned - deformation and orientation is appropriate for the current temperature. The elastomeric covering may have superficial deterioration (the steel reinforcement layers are not exposed). Pintle plates, restraints, or anchor bolts (if present) are sound, properly positioned, and functioning as intended. The bearing seat is in good condition (there is no loss of bearing area).

Condition State 2: Elastomeric expansion bearing has moderate deterioration - bearing function may be slightly impaired. Bearing pad deformation may be near the design limits (25% of the pad thickness), or the orientation may be inappropriate for the current temperature (resetting may be recommended). The pad may have bulged, deformed laterally, or moved slightly out of position. The elastomeric covering may have split or torn (steel reinforcement layers may be exposed). Pintle plates, restraints, or anchor bolts (if present) may have moderate deterioration, slight binding, or may be slightly out of position). The bearing seat may have moderate deterioration (there may be a slight loss of bearing area).

Condition State 3: Elastomeric expansion bearing has severe deterioration - resetting or replacement may be required. Bearing pad deformation may be beyond the design limits (25% of the pad thickness) - the pad may severely bulged or significantly out of position. The elastomeric covering may have failed (steel reinforcement layers may have severe corrosion or de-bonding). Pintle plates, restraints, or anchor bolts (if present) may have failed, or may be significantly out of position. Bearing seat may have severe deterioration (there may be significant loss of bearing area) - supplemental supports or load restrictions may be warranted.

Element #311 - Expansion Bearings

This element applies to mechanical expansion bearings of any type - such as sliding plate bearings, rocker bearings, or roller 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 slotted slates.

- 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 or multiple rollers (“rollernest bearing”). Lateral restraint may be provided by pintles (on the top & bottom of the roller), or keeper bars attached the ends of the rollers.

- 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 or multiple rockers (“rockernest bearing”). Lateral restraint may be provided by pintles (attached to the masonry plate), pin caps, or anchor bolts extending up through slotted slates.

Condition State 1: Expansion bearing is in good condition and is functioning as intended. Bearing alignment is within design limits and is appropriate for the current temperature. Bearing assembly is relatively free of debris (no restriction of movement). Paint system (if present) may have some deterioration - corrosion may be present, but there is no significant section loss. Lubrication system (if any) is functioning properly. All bearing components (sliding plates, rockers, rollers, pins, etc.) are intact and properly positioned. Lateral guide/restraint system (or uplift restraint system, if present) is in good condition. Anchor bolts are bearing seat are sound (there is no loss of bearing area).

Condition State 2: Expansion bearing has moderate deterioration - bearing function may be slightly restricted (cleaning, painting, or lubrication may be recommended). Bearing alignment may be at or near the design limits (or inappropriate for the current temperature), but is still tolerable. Bearing assembly may have extensive corrosion (section loss may be present), or may be covered with debris. Lubrication system may have failed. Primary bearing components (sliding plates, rockers, rollers, pins, etc.) may be moderately worn or slightly out of alignment. Secondary bearing components (cotter pins, etc.) may be loose or missing. The lateral guide/restraint system (guide tabs, keeper bars, pintles, pin caps, etc.) may be moderately worn or slightly out of alignment (there may be minor binding). Uplift restraint system (if present) may have moderate deterioration, but is still functioning as intended. Anchor bolts may be corroded or bent, but remain intact. The bearing seat may have moderate deterioration (there may be a slight loss of bearing area).

Condition State 3: Expansion bearing has severe deterioration, and is no longer functioning as intended (repair or replacement may be necessary). Bearing alignment may be beyond design limits. Bearing mechanism may be frozen (seized) or severely restricted due to corrosion or debris. Primary bearing components (sliding plates, rockers, rollers, pins, etc.) may severe section loss, wear, or misalignment - they may have jammed, come loose or otherwise failed. The lateral guide/restraint system (guide tabs, keeper bars, pintles, or pin caps) may have sheared off, bound, or otherwise failed. Uplift restraint system may have failed. Anchor bolts may have failed. Bearing seat may have severe deterioration (there may be significant loss of bearing area) - supplemental supports or load restrictions may be warranted.

Element #312 - Enclosed or Concealed Bearings

This element applies to bearing assemblies that are enclosed or concealed, and are not visible for detailed inspection. This can include either fixed or expansion bearings.

Condition State 1: Enclosed/Concealed bearing is in good condition and is functioning as intended. Horizontal, lateral and vertical alignment is within limits and is appropriate for the current temperature. The bearing seat is sound (there is no loss of bearing area).

Condition State 2: Enclosed/Concealed bearing has moderate deterioration (repairs may be recommended). Horizontal, lateral or vertical alignment may be near design limits (or inappropriate for the current temperature). The bearing seat may have moderate deterioration (there may be a slight loss of bearing area).

Condition State 3: Enclosed/Concealed bearing has severe deterioration - repair or replacement may be necessary. Horizontal, lateral or vertical alignment may be beyond the design limits. Bearing seat may have severe deterioration (there may be significant loss of bearing area) - supplemental supports or load restrictions may be warranted.

Element #313 - Fixed Bearings

This element applies to bearings that are fixed against longitudinal movement of the superstructure. Fixed bearings may incorporate a pin or a 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.

Condition State 1: Fixed bearing is in good condition and is functioning as intended. Bearing assembly is relatively free of debris (no restriction of movement). Paint system (if present) may have some deterioration - corrosion may be present, but there is no significant section loss. All bearing components are intact and properly positioned. Anchor bolts are bearing seat are sound (there is no loss of bearing area).

Condition State 2: Fixed bearing has moderate deterioration - cleaning or painting may be recommended. Bearing assembly may have extensive corrosion (section loss may be present), or may be covered with debris. Primary bearing components (castings, pins, pads, etc.) may be moderately worn or slightly out of alignment. Secondary bearing components (cotter pins, lead plates, sole plate bolts, etc.) may be working out, loose, or missing. Anchor bolts may be corroded, but remain intact. The bearing seat may have moderate deterioration (there may be a slight loss of bearing area).

Condition State 3: Fixed bearing has severe deterioration, and is no longer functioning as intended (repair or replacement may be necessary). Primary bearing components may have severe section loss, wear, misalignment, or may have otherwise failed. Anchor bolts may have failed. Bearing seat may have severe deterioration (there may be significant loss of bearing area) - supplemental supports or load restrictions may be warranted.

Element #314: Pot Bearings
Element #315: Disk Bearings

Pot and Disk bearings allow for multi-dimensional rotational movement - these are specialized bearings used only for high loads (long spans, steel pier caps, or railroad bridges). Pot/Disk bearings may be either fixed or expansion.

- Pot bearings consist of a shallow steel piston that rests within a steel cylinder (which contains a confined elastomer). Typically, only the perimeter edge of the elastomer is visible for inspection.
- Disc bearings consist of a shallow steel piston that rests within a steel cylinder (which contains a hard plastic disc. Typically, the disc is enclosed within the assembly and is not visible for inspection. *Note: high load bearings which utilize a semi-spherical steel bearing plate can also be considered to be a "Disc" bearing.*

The upper piston plate should be properly seated (and positioned) within the lower cylinder plate. Any exposed portions of the elastomer or disc should be examined for splitting, tearing, or extrusion.

On expansion Pot bearings, the upper plate typically has a stainless steel plate (with a "mirror finish") welded to the underside, while the lower plate typically has PFTE (polytetrafluoroethylene) bonded to the top surface. This combination provides an extremely low friction sliding surface (lubrication is not required). The upper sliding plate should be examined evidence of separation (such as cracked welds) of the stainless steel - the extent of any recent movement can often be determined by examining the stainless steel plate. The lower plate should be examined for any de-bonding of the PTFE. Expansion Pot bearings may be "guided" (lateral movement is restricted) or "non-guided" (free to move laterally). On unguided expansion bearings, note any evidence of lateral movement. On guided expansion bearings, look for evidence of wear, binding, or deterioration of the guide system.

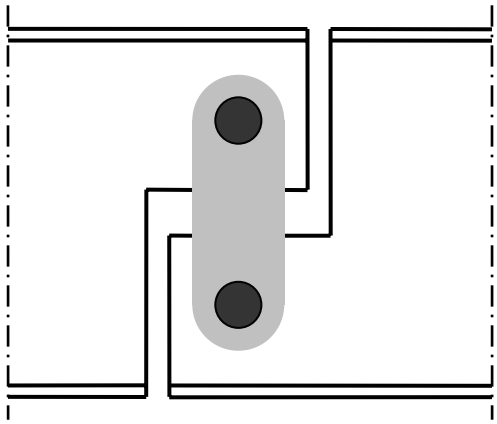
Condition State 1: Pot/Disc bearing is in good condition and is functioning as intended. On expansion bearings, alignment is within design limits and is appropriate for the current temperature. Bearing is free of corrosion and debris (no restriction of movement). All bearing components are properly aligned and properly seated. Confined elastomer has little or no deterioration - there is no evidence of the elastomer extruding from the cylinder. Guide/restraint devices (if present) are intact and are functioning properly. Anchor bolts are bearing seat are sound (there is no loss of bearing area).

Condition State 2: Pot/Disc bearing has moderate deterioration - bearing function may be slightly restricted (cleaning or repair may be recommended). On expansion bearings, alignment may be near design limits (or inappropriate for the current temperature), but is still tolerable. Bearing assembly may have corrosion or may be covered with debris (there may be a slight restriction of movement). Primary bearing components (piston, cylinder, sliding plate, etc.) may be slightly tipped, offset, or out of alignment. Confined elastomer may have some deterioration, or may have started to extrude along the edge of the cylinder. Guide/restraint devices (if present) may be worn, loose, or out of alignment (there may be minor binding). Anchor bolts may be corroded, but remain intact. The bearing seat may have moderate deterioration (there may be a slight loss of bearing area).

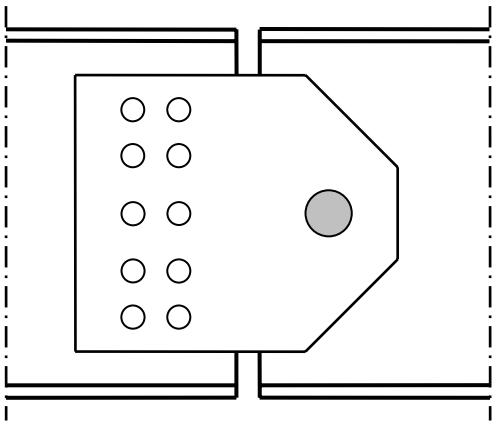
Condition State 3: Pot/Disc bearing has severe deterioration, and is no longer functioning as intended (repair or replacement may be necessary). On expansion bearings, alignment may be beyond design limits. Bearing mechanism may be frozen (seized) or severely restricted Primary bearing components may severe section loss, wear, or misalignment - they may have jammed, come loose or otherwise failed. Confined elastomer may have severe deterioration, or may be actively extruding from the cylinder. Guide/restraint devices (if present) may have failed. Anchor bolts may have failed. Bearing seat may have severe deterioration (there may be significant loss of bearing area) - supplemental supports or load restrictions may be warranted.

3.5.2 Pin & Hanger (or Fixed Pin) Assemblies

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. A pin & 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. A fixed pin assembly typically consists of a single pin - this allows rotation, but restricts longitudinal movement of the superstructure.



Pin & Hanger Assembly



Fixed Pin Assembly

Pinned assemblies are relatively rare in Minnesota - most are found on multiple girder/beam bridges constructed from 1935-1975, but some can be found on long-span two-girder or truss bridges (on truss bridges, the hanger member may be similar to other truss members). On any bridge that carries highway traffic, pinned assemblies are considered to be “special features”, and require periodic ultrasonic examination (see Mn/DOT Tech Memo #02-22-B-01). On two-girder or truss bridges (that carry highway traffic), pinned assemblies are considered to be “fracture critical” members - the failure of a pin or hanger plate could result in the collapse of a span.

On a typical suspended span, one end is supported by fixed pin assemblies, while the expansion end is supported by pin & hanger assemblies To prevent lateral movement of the superstructure, the expansion end will often incorporate a guide/restraint system (such as a wind transfer pin assembly). Some bridges in Minnesota (particularly along the Red River Valley) have “swivel hinges” - the center girder will have a fixed pin assembly, while the other girders will all have pin & hanger assemblies.

Pinned assemblies should be examined for deterioration, function, alignment, as well as the soundness of the 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 & hanger assemblies (be sure to record the temperature at the time of inspection). As a frozen pin will transfer additional bending stresses to the hanger plates, any significant restriction of a pin & 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.*

Element #161: Pin & Hanger (or Fixed Pin) Assembly

- **Element #160: Pin & Hanger (or Fixed Pin) Assembly - Unpainted Weathering Steel**
- **Element #161: Pin & Hanger (or Fixed Pin) Assembly - Painted Steel**

There are two AASHTO CoRe elements for pinned assemblies. However, Mn/DOT only uses Element #161 (Element #160 should not be used - the condition rating description for this element is not included in this manual). Element #161 should be used for all pin & hanger (or fixed pin) assemblies - this is an "each" item, a single condition state must be determined for each pinned assembly.

Condition State 1: Pinned assembly has little or no deterioration - it is free of debris and properly aligned. All components (pins, plates, pin caps, nuts, washers, spacers, etc.) are in good condition. Paint system (if present) is sound - there is no notable corrosion (or section loss). Supporting steel superstructure has little or no deterioration.

Condition State 2: Pinned assembly has minor deterioration. There may be minor debris, but there is no restriction of movement - lubrication system (if present) is functioning properly. Assembly components (pins, plates, pin caps, nuts, washers, spacers, etc.) may have minor wear or deterioration, but remain in proper position. Longitudinal alignment is within design limits and is appropriate for the current temperature. Lateral restraint/guide systems (if present) are functioning as intended - there is no notable lateral misalignment. Paint system (if present) may have some deterioration - corrosion may be present, but any section loss (or pack rust) is incidental. Supporting steel superstructure may have minor deterioration.

Condition State 3: Pinned assembly has moderate deterioration, but is still functioning as intended. Debris or corrosion may have resulted in a slight restriction of movement (cleaning and/or lubrication may be recommended). Pins or plates may have moderate wear (fretting rust may be present). Primary connections (nuts, pin caps, etc.) remain intact - secondary components (washers, spacers, cotter pins, etc.) may be loose or misaligned. Longitudinal alignment may be near the design limits, or may be somewhat inappropriate for the current temperature. Lateral restraint/guide systems may be worn or loose - there may be slight lateral misalignment. Paint system (if present) may have extensive deterioration - surface corrosion may be prevalent (notable section loss or pack rust may be present). Supporting steel superstructure may have moderate deterioration.

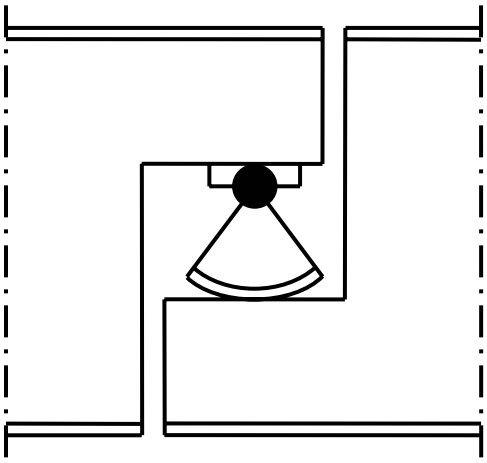
Condition State 4: Pinned assembly has extensive deterioration - the function may be impaired, but the load-carrying capacity has not been significantly reduced. Debris or corrosion may be restricting movement (cleaning and/or lubrication may be required). Pins or plates may have extensive wear or slight deformation (cracks or other defects may be present). Primary connections (nuts, pin caps, etc.) may have started to work loose - secondary components (washers, spacers, cotter pins, etc.) may be missing. Longitudinal alignment may be at the design limits (contacting or binding), or may be completely inappropriate for the current temperature. Lateral restraint/guide systems may have failed, or there may be excessive lateral misalignment. Paint system (if present) may have failed - there may be extensive corrosion, with significant section loss (or pack rust). Supporting steel superstructure may have extensive deterioration.

Condition State 5: Pinned assembly has severe or critical deterioration. The load-carrying capacity has been significantly reduced - structural analysis or immediate repairs may be required. Movement may be completely restricted (assembly may be frozen or binding). Pins or plates may have severe wear, deformation, or cracking. There may be severe longitudinal or lateral misalignment. Primary connections may have failed. There may be severe section loss or pack rust. Supporting steel superstructure may have severe or critical deterioration.

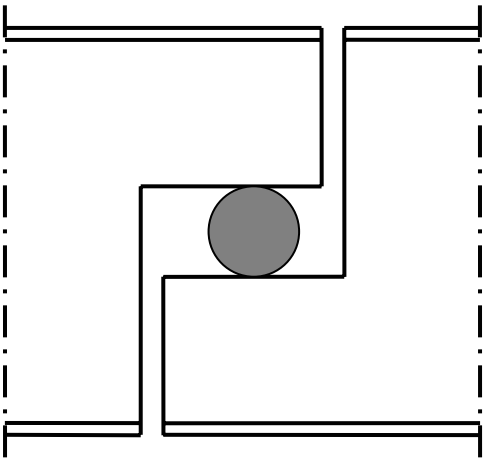
3.5.3 Hinge Bearing Assemblies

On continuous 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 hinge bearing assembly. Hinge bearings may be expansion (permitting longitudinal movement of the superstructure) or fixed (resisting longitudinal movement of the superstructure). Most hinge bearings are designed to allow rotation of the superstructure due to live load deflection - some are designed to restrict lateral movement of the superstructure. Hinge bearings can include a wide variety of bearing assembly types (rocker, roller, sliding plate, or elastomeric pad).

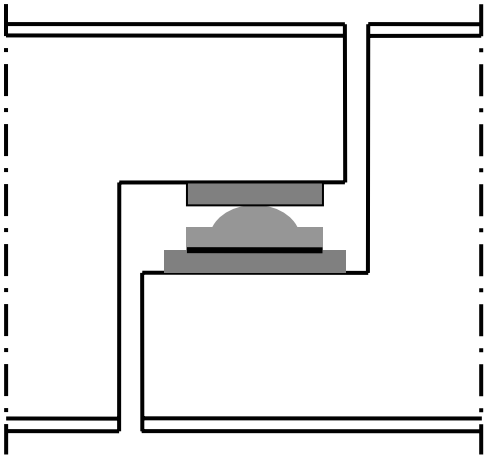
In Minnesota, hinge bearings are very common on steel multi-beam bridges constructed in the 1960's and 1970's - they can also be found on concrete box girder and steel truss bridges (they are seldom used in new bridges). Incorporating a hinge bearing simplifies structural analysis, as by allowing rotation, the bending moments are isolated. Hinge bearings are typically "cantilevered" (offset from the piers), to reduce deterioration of the substructure from leaking deck joints.



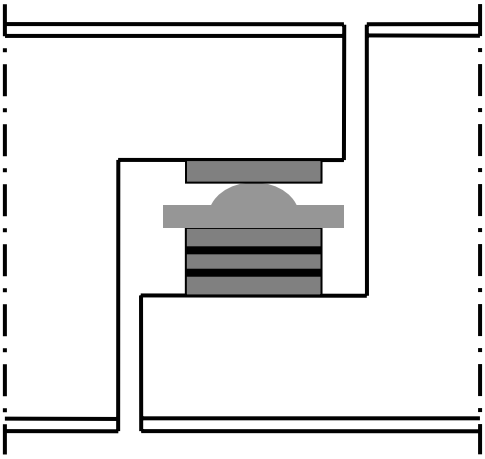
Rocker Hinge Bearing



Roller Hinge Bearing



Sliding Plate Hinge Bearing



Elastomeric Hinge Bearing

While hinge bearing assemblies are not classified as "special features" (like pin & hanger assemblies), these details should be given special attention during each inspection. A malfunctioning hinge bearing could result in damage to adjacent deck, superstructure, or substructure elements. Misalignment of a hinge bearing may indicate significant problems elsewhere on the bridge (such as substructure settlement or tipping).

As there are no AASHTO CoRe elements to rate the condition of hinge bearing assemblies, Mn/DOT has added two Pontis elements…

- **Element #373: Steel Hinge Assembly (Painted or Unpainted)**
- **Element #379: Concrete Hinge Assembly**

Element #373 applies to hinge bearings on steel superstructures (it is rated on a scale of 1-5); Element #379 applies to hinge bearings on concrete superstructures (it is rated on a scale of 1-4). Hinge bearing assemblies should be examined for deterioration, function, alignment, as well as the soundness of the superstructure support. All of these factors should be taken into consideration when rating a hinge bearing element.

During a routine inspection, hinge bearings are typically observed from ground level (binoculars are helpful). If problems are observed during a routine inspection, an in-depth inspection (using some type of access equipment) should be scheduled. The following items should be emphasized when inspecting a hinge bearing assembly…

- Hinge bearing assemblies should be examined for corrosion or debris. Adjacent deck joints and deck drainage systems should be examined for leakage, clogging, or other malfunction that might be subjecting the hinge bearing to excessive water, salt, or debris.

- The hinge bearing components (rockers, rollers, sliding plates, elastomeric pads, pins, nuts, washers, cotter pins, spacers & guide tabs) should be examined for wear, corrosion, defects, cracks, bending, loosening or misalignment. Excessive movement (or noise) at the hinge bearing under live loads may indicate bearing malfunction.

- On expansion hinge bearings, proper function is a primary concern - the inspector should verify that longitudinal movement is not restricted (any significant restriction should be identified and analyzed immediately). Obvious visual evidence of recent movement (such as scrape marks on contact surfaces) should be noted. The adjacent superstructure and deck should be examined for any evidence of contacting (or binding) that might be restricting expansion. To verify proper function, periodic measurements should be taken (preferably at a clean, easily identifiable location) - be sure to record the temperature when the measurements were taken. If the hinge bearings cannot be accessed up-close, measurements can be taken at adjacent deck joints, curb plates, or railings.

- The longitudinal and lateral alignment of the hinge bearing should be observed and noted (any significant misalignment should be identified and analyzed immediately). On expansion hinge bearings, the longitudinal alignment should be appropriate for the current temperature, and the alignment of adjacent hinge bearings should be similar.

- Like any bearing assembly, the condition of the bearing support member is also of concern, and may affect the rating. The superstructure adjacent to the hinge bearing assembly should be examined for deterioration (or evidence of structural distress). On steel beams, the webs, flanges, and bearing stiffeners should be examined for corrosion, section loss, bulking, or cracking. On concrete box girders, the concrete surfaces should be examined for structural cracking, leaching, rust staining, delamination, or spalling (internal inspection of the hinge area is recommended).

Element #373: Steel Hinge Assembly (Painted or Unpainted)

This element applies to hinge bearing assemblies on steel girders, beams, stringers, trusses (or other steel bridges). This includes hinge bearing assemblies of any type (rocker, roller, sliding plate, or elastomeric pad), and includes both expansion and fixed hinge bearing assemblies. While this element typically refers to cantilever hinges on steel beams or girders, it can be used to rate any bearing assembly where a steel superstructure element bears upon another steel superstructure element. This is an “each” item, a single condition state must be determined for each hinge assembly.

Condition State 1: Steel hinge bearing assembly has little or no deterioration - it is free of debris and properly aligned. All bearing components (rockers, rollers, sliding plates, pads, pins, nuts, washers, cotter pins, etc.) are in good condition. Paint system (if present) is sound - there is no notable corrosion. Supporting steel superstructure has little or no deterioration.

Condition State 2: Steel hinge bearing assembly has minor deterioration. There may be minor debris, but there is no restriction of movement - lubrication system (if present) is functioning properly. Bearing components (rockers, rollers, sliding plates, pads, pins, nuts, washers, cotter pins, etc.) may have minor wear or deterioration, but remain in proper position. Longitudinal alignment is within design limits and is appropriate for the current temperature. Lateral restraint/guide systems (if present) are functioning as intended - there is no notable lateral misalignment. Paint system may have some deterioration - corrosion may be present, but any section loss is incidental. Supporting steel superstructure may have minor deterioration.

Condition State 3: Steel hinge bearing assembly has moderate deterioration, but is still functioning as intended. Debris or corrosion may have resulted in a slight restriction of movement (cleaning and/or lubrication may be recommended). Primary bearing components (rockers, rollers, sliding plates, elastomeric pads, pins, etc.) may have moderate wear (or deterioration), or slight misalignment. Secondary bearing components (bolts, nuts, washers, spacers, guides, cotter pins, etc.) may be loose or missing. Longitudinal alignment may be near the design limits, or may be somewhat inappropriate for the current temperature. Lateral restraint/guide systems may be worn, loose, or slightly binding - there may be slight lateral misalignment. Paint system may have extensive deterioration - surface corrosion may be prevalent (notable section loss may be present). Supporting steel superstructure may have moderate deterioration.

Condition State 4: Steel hinge bearing assembly has extensive deterioration - bearing function may be impaired, but the load-carrying capacity has not been significantly reduced. Debris or corrosion may be restricting movement (cleaning and/or lubrication may be required). Primary bearing components (rockers, rollers, sliding plates, elastomeric pads, pins, etc.) may have extensive wear (or deterioration), or may be misaligned. Longitudinal alignment may be at the design limits (contacting or binding), or may be completely inappropriate for the current temperature. Lateral restraint/guide systems may have failed, or there may be excessive lateral misalignment. Paint system may have failed - there may be extensive corrosion, with significant section loss. Supporting steel superstructure may have extensive deterioration.

Condition State 5: Steel hinge bearing assembly has severe or critical deterioration. The load-carrying capacity has been significantly reduced - structural analysis or immediate repairs may be required. Bearing movement may be completely restricted (primary bearing components may be frozen, binding, or severely out of alignment.). Longitudinal or lateral misalignment may have resulted in significant loss of bearing area. There may be severe section loss. Supporting steel superstructure may have severe or critical deterioration.

Element #379: Concrete Hinge Assembly

This element applies to hinge bearing assemblies on concrete box girders (or other concrete bridges). This includes hinge bearing assemblies of any type (rocker, roller, sliding plate, or elastomeric pad), and includes both expansion and fixed hinge bearing assemblies. While this element typically refers to cantilever hinges on concrete box girders, it can be used to rate any bearing assembly where a concrete superstructure element bears upon another concrete superstructure element. This is an “each” item, a single condition state must be determined for each hinge assembly (if the quantity of individual bearings cannot be determined, the entire hinge joint can be rated as one unit).

Condition State 1: Concrete hinge bearing assembly has little or no deterioration. There may be minor debris, but there is no restriction of movement - lubrication system (if present) is functioning properly. All bearing components (rockers, rollers, sliding plates, pads, pins, nuts, washers, cotter pins, etc.) are in good condition. Longitudinal alignment is within design limits and is appropriate for the current temperature. Lateral restraint/guide systems (if present) are functioning as intended - there is no notable lateral misalignment. Supporting concrete superstructure may have superficial cracking or staining, but there are no delaminations, spalls, or repair patches.

Condition State 2: Concrete hinge bearing assembly minor to moderate deterioration, but is still functioning as intended. Debris or corrosion may have resulted in a slight restriction of movement (cleaning and/or lubrication may be recommended). Primary bearing components (rockers, rollers, sliding plates, elastomeric pads, pins, etc.) may have moderate wear, moderate deterioration, or slight misalignment. Secondary bearing components (bolts, nuts, washers, spacers, guides, cotter pins, etc.) may be loose or missing. Longitudinal alignment may be near the design limits, or may be somewhat inappropriate for the current temperature. Lateral restraint/guide systems may be worn or loose - there may be slight lateral misalignment. Supporting concrete superstructure may have moderate cracking, scaling, leaching, or staining. There may be some delamination & spalling - but any exposure of reinforcement or tensioning steel is limited. Patched areas (if any) remain sound.

Condition State 3: Concrete hinge bearing assembly has extensive deterioration - the function may be impaired, but the load-carrying capacity has not been significantly reduced. Debris or corrosion may be restricting movement (cleaning and/or lubrication may be required). Primary bearing components (rockers, rollers, sliding plates, elastomeric pads, pins, etc.) may have extensive wear, extensive deterioration, or significant misalignment. Longitudinal alignment may be at the design limits (contacting or binding), or may be completely inappropriate for the current temperature. Lateral restraint/guide systems may have failed, or there may be excessive lateral misalignment. Supporting concrete superstructure may have extensive scale, cracking, leaching, or rust/water staining. There may be significant delamination & spalling (exposed reinforcement or tensioning system may have some section loss). Structural cracks (shear or flexure) may be present.

Condition State 4: Concrete hinge bearing assembly has severe or critical deterioration. The load-carrying capacity has been significantly reduced - structural analysis or immediate repairs may be required. Bearing movement may be completely restricted (primary bearing components may be frozen, binding, or severely out of alignment.). Longitudinal or lateral misalignment may have resulted in significant loss of bearing area. Supporting concrete superstructure may have severe structural cracking or spalling (exposed reinforcement or tensioning system may have significant section loss).

3.5.4 Steel Cables

Steel cables are used in suspension bridges, cable-stayed bridges, and tied arch bridges. The rating should take into consideration both the condition of the cable, as well as the condition of the cable anchorage.

Element #146: Steel Cable - Uncoated

This element applies to bare steel cables (such as suspension, hanger, or tie cables) that serve as a primary structural element on a bridge. The quantity is expressed as an each item.

Condition State 1: Steel cable (including cable anchorages) has little or no corrosion.

Condition State 2: Steel cable may have moderate surface corrosion (no section loss). Cable banding is intact. Cable anchorages have no evidence of distress.

Condition State 3: Steel cable may extensive surface corrosion, but any section loss is incidental (the load carrying capacity has not been reduced). There may be minor wear or abrasion at contact points. Cable banding may have started to loosen. Cable anchorages may show evidence of loosening or slight slippage.

Condition State 4: Steel cable may have advanced corrosion (significant section loss). The load carrying capacity has been reduced - structural analysis or immediate repairs may be required. Cable may have severe wear or abrasion at contact points. Cable banding may have failed - cable strands may be loose or broken. Cable anchorages may have significant slippage.

Element #147: Steel Cable - Coated or Encased

This element applies to coated steel cables (such as suspension, hanger, or tie cables) that serve as a structural element on a bridge. This can include cables that are painted, galvanized, covered with a protective sheathing, or encased in a conduit. The quantity is expressed as an each item.

Condition State 1: Cable coating (or encasement) is sound and functioning as intended to protect the cable (and cable anchorages) - there is no corrosion.

Condition State 2: Cable coating (or encasement) may have minor deterioration (peeling, cracking, fading, etc.) - surface corrosion may have formed.

Condition State 3: Cable coating (or encasement) has moderate deterioration - surface corrosion may be prevalent, but there is no section loss. Cable may have superficial wear or abrasion at contact points. Cable anchorages have no evidence of distress.

Condition State 4: Cable coating (or encasement) has extensive deterioration. There may be extensive surface corrosion, but any section loss is incidental (the load carrying capacity has not been reduced). There may be minor wear or abrasion at contact points. Cable banding may have started to loosen. Cable anchorages may show evidence of loosening or slight slippage.

Condition State 5: Coated steel cable may have advanced corrosion (significant section loss). The load carrying capacity has been reduced - structural analysis or immediate repairs may be required. Cable may have severe wear or abrasion at contact points. Cable banding may have failed - cable strands may be loose or broken. Cable anchorages may have significant slippage.

3.5.5 Secondary Structural Elements

Element #380: Secondary Structural Elements

This element applies to any type of secondary structural element. This can include superstructure members such as diaphragms, lateral bracing, struts, truss portal & sway bracing, or shear keys. This can include substructure elements such as pier crash struts or cross bracing. This can include specialized elements on movable spans (such as sheaves, trunnions, turntables, or counterweights). This includes any material (or combination of materials). The quantity is expressed as an each item - the quantity can be listed as “1” (it isn’t necessary to count the total number of secondary elements on a bridge).

Condition State 1: Secondary elements have little or no deterioration. Steel members have little of no corrosion - the paint system (if present) is sound & functioning. Concrete members may have superficial cracking. Timber members may have superficial cracking or splitting. All connections are sound (no evidence of distress).

Condition State 2: Secondary elements have minor to moderate deterioration. Steel members may have moderate paint failure or surface rust - there may be minor flaking or pack rust, but only minimal section loss. Concrete surfaces may have moderate staining, scale, cracking, or leaching - there may be minor delaminations & spalls, but there is minimal exposure of reinforcement. Timber members may have moderate cracks, splits, checks, decay, or fire damage - but there is no evidence of structural distress (crushing or sagging). Connections may show have minor distress. There may be superficial traffic impact damage (minor gouges, spalls, or scrapes), but there is no significant out of plane bending. The element may have been repaired, or had some sections replaced. Any patched, spliced, or reinforced areas are sound.

Condition State 3: Secondary elements have extensive deterioration, but the element is still functioning as intended. Steel members & connections may have extensive corrosion, with measurable section loss. Concrete surfaces may have extensive scale, cracking, or leaching/rust staining. Delamination & spalling may be prevalent (exposed rebar may have measurable section loss). Timber members may have extensive splits, checks, decay, or fire damage - there may be some sagging or crushing. There may be moderate traffic impact damage (significant cracking or spalling) - the member may be bent out of plane. Repaired or reinforced areas may have been re-damaged or began to deteriorate. Connections may be loosening.

Condition State 4: Secondary elements have severe damage deterioration. Element is no longer functioning as intended - structural analysis or immediate repairs may be required. Steel members & connections may have advanced corrosion, with severe section loss. There may be significant fatigue cracks. Concrete surfaces may have severe structural cracking or extensive spalling (exposed rebar may have severe section loss). Timber members may have severe structural cracking, sagging, or advanced decay. There may be severe traffic impact damage - members may be severed or bent severely out of plane, connections may have been torn loose. Connections may have failed.

3.5.6 Cast-in-Place (CIP) Piling

Element #382 (Cast-in-Place Piling): This element applies to steel shell piling (typically cylindrical in cross-section) that are filled with concrete after being driven. The quantity is expressed as an each item.

Condition State 1: CIP piling has little or no deterioration. Paint system (if present) remains sound. The steel shell may have minor staining or corrosion, but there is no section loss. There is no notable marine growth. Piling is relatively straight and properly positioned.

Condition State 2: CIP piling has minor to moderate deterioration. Paint system (if present) may have moderate deterioration. The steel shell may have moderate surface corrosion, but any section loss is minor. Marine growth may be present. Piling may be slightly bowed, bent, or out of position.

Condition State 3: CIP piling has extensive deterioration, but the load-carrying capacity has not been significantly reduced. Paint system may have failed. The steel shell may have extensive flaking rust (with significant section loss), but there is no exposure of the concrete fill. There may be extensive marine growth. Piling may be significantly bowed, bent, or out of position.

Condition State 4: CIP Piling has severe or critical deterioration. The load-carrying capacity of the piling has been significantly reduced - immediate repairs or structural analysis may be required. The steel shell may have advanced corrosion (with severe section loss) - the concrete fill may be exposed. Piling may be severely bowed, bent, or out of position.

3.5.7 Tunnels

Element #381 (Tunnels): This element applies to roadway tunnels of any type or material. This element includes tunnels constructed by boring, blasting, or by “cut and fill”. Tunnels are typically constructed of (or lined with) reinforced concrete - exposed surfaces often protected with tile. The quantity is expressed as a “linear ft.” item and is rated on a scale of 1-4.

Condition State 1: Tunnel has little or no deterioration. Tiles surfaces are sound (there may be superficial scraping, staining, or discoloration). Concrete surfaces may have superficial cracking, scaling, or leaching (there are no notable delaminations or spalls). Joints have no notable leakage, separation, offset, or misalignment.

Condition State 2: Tunnel has minor to moderate deterioration. Tile surfaces may have moderate staining, discoloration, or deterioration - some tiles may be cracked, delaminated, loose, or missing. Concrete surfaces may have moderate cracking, scaling, or leaching. There may be minor delamination or spalling - any exposure of reinforcement is minimal. Joints may have minor leakage, separation, offset, or misalignment (there is no notable backfill infiltration).

Condition State 3: Tunnel has extensive deterioration, but the function or structural capacity of the tunnel has not been significantly impaired. Tile surfaces may have extensive deterioration - numerous tiles may be cracked, delaminated, loose, or missing. Concrete surfaces may have extensive cracking, scaling, or leaching. There may be significant structural cracking. Delamination or spalling may be prevalent (exposed rebar may have measurable section loss). Joints may have significant leakage, separation, offset, or misalignment (there may be minor backfill infiltration).

Condition State 4: Tunnel has severe or critical deterioration. The function or structural capacity of the tunnel has been severely impacted - immediate repairs or structural analysis may be required. Tile surfaces may have complete failure (the majority of tiles are missing). Concrete surfaces may have severe scaling or spalling (exposed reinforcement may have significant section loss). There may be severe structural cracking. Joints may have failed - there may be severe leakage, separation, offset, or misalignment (there may be significant backfill infiltration).

3.6 Pontis Culvert Elements

3.6.1 Inspection Procedures for Culverts

While the FHWA requires inspection of any structure with a total length of 20 ft. or greater, Minnesota State law requires inspection of any structure with a total length of 10 ft. or greater - thus, the Mn/DOT structure inventory includes many small (10-20 ft.) culverts.

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 barrel, end treatments, waterway, embankment slopes, and the roadway. Ideally, a walk-through inspection of the entire the 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.

- 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.

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, delaminations, 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, 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, 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. Bolted seams should be checked with a torque wrench (125 ft-lbs to 150 ft-lbs).

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 differential 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 & 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 leaking 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.

3.6.2 Condition Rating Guidelines for Culverts

Like bridges, culverts must be rated using both the NBI and Pontis element condition ratings…

NBI Condition & Appraisal Ratings: The overall structural condition of a culvert should be rated using the NBI Culvert Rating (FHWA Item #62 - see Section 2.1.5). The NBI condition ratings for deck, superstructure, and substructure (FHWA Items #58, 59, and 60) should all be listed as "N".

If the culvert is designed to carry water (even when the channel running through the culvert is normally dry), the channel should be rated using NBI Channel & Channel Protection Condition Rating (FHWA Item #61- see Section 2.1.4). This rating should reflect the channel alignment, as well as the presence of any sedimentation or debris. Note: If FHWA Item #61 is rated, the Waterway Adequacy Appraisal Rating (FHWA Item #71- see Section 2.2.1) must also be rated - this rating is primarily based upon the frequency of overtopping of the roadway during high water events.

Pontis Element Condition Ratings: The condition of the culvert barrel should be rated using one of the four AASHTO CoRe 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 (all culvert barrel elements are rated on a scale of 1-4).

- **Element #240 - Steel Culvert (LF)**
- **Element #241 - Concrete Culvert (LF)**
- **Element #242 - Timber Culvert (LF)**
- **Element #243 - Masonry, Combination, or Other Material Culvert (LF)**

Mn/DOT has added Element #388 to rate the condition of the headwalls, wingwalls, and aprons (or any other type of culvert end treatment), and has added Element #421 to rate the condition of culvert footings.

The condition of the roadway above the culvert should be rated using Element #987 (roadway over 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 centerline of the culvert. On rigid (concrete) culverts, look for settlement along the edges of the culvert. If applicable, the inspector should also rate Element #981 (signing) and Element #982 (approach guardrail).

The condition of the culvert embankment slopes should be rated using Element #985 (slopes & slope protection) - embankment erosion may be the result of channel scour or roadway drainage. If scour is present, Element #361 (scour smart flag) should be also be rated, if slope erosion is due to roadway drainage, Element #984 (deck & approach drainage) should also be rated.

Related Structure Inventory Items: The Mn/DOT structure inventory includes three culvert items - the culvert type, the culvert barrel length, and the culvert fill depth. The culvert type item describes the culvert material, barrel dimensions, and number of barrels. The culvert barrel length item indicates the culvert barrel length (to the nearest foot) as measured along the centerline of the culvert. These two inventory items should correlate with the Pontis elements selected for the culvert.

The culvert fill depth item indicates the total depth of fill material (including the wearing surface, if any) that is supported by the culvert. This item is displayed to feet (rounded to the hundreds of a foot). The inspector should note the culvert fill depth on the inspection report, as this may affect the load-carrying capacity of the culvert. For example, if the roadway has been widened (and the culvert extended), the embankment depth may increase significantly.

3.6.3 Steel Culvert (Element #240)

This element applies to steel culverts of any type or shape.

Condition State 1: Steel culvert has little or no deterioration. The barrel has no deflection or distortion. The protective coating (if any) is sound. There may be minor staining or surface corrosion, but there is no section loss. All seams and joints are sound - there is no distress or leakage.

Condition State 2: Steel culvert has minor to moderate deterioration. The barrel may have slight deflection or distortion. The protective coating (if any) may have moderate deterioration. There may be moderate surface corrosion or minor section loss (surface pitting). Bolted seams may have minor distress, but all bolts are secured, and there is no cracking around the bolt holes. Joints may have minor leakage, but there is no backfill infiltration.

Condition State 3: Steel culvert has extensive deterioration, but the function or structural capacity of the culvert has not been significantly impaired. The barrel may have measurable deflection or distortion (sagging, flattening, or buckling). The protective coating may have failed. There may be extensive surface corrosion or measurable section loss. Bolted seams may have obvious distress (seams may be cusped or cocked). Bolts may be loose or misaligned - cracks may have formed around the bolt holes. Joints may have moderate leakage - there may be minor backfill infiltration.

Condition State 4: Steel culvert has severe or critical deterioration. The function or structural capacity of the culvert has been severely impacted - immediate repairs or structural analysis may be required. The barrel may have severe deflection or distortion (sagging, buckling, or crown reversal). There may be advanced corrosion & severe section loss (large sections rusted through). Bolted seams may have failed. Joints may have severe leakage or separation - there may be significant backfill infiltration.

3.6.4 Concrete Culvert (Element #241)

This element applies to reinforced concrete culverts (pre-cast or cast-in-place) of any type or shape.

Condition State 1: Concrete culvert has little or no deterioration. There may be superficial cracking, scaling, leaching, or staining (there are no delaminations or spalls). Joints have no leakage, separation, offset, or misalignment. Connection bolts (if any) may have minor surface corrosion.

Condition State 2: Concrete culvert has minor to moderate deterioration. There may be moderate cracking, scaling, leaching, or staining. There may be minor delamination or spalling - but any exposure of reinforcement is minimal. Joints may have minor leakage, separation, offset, or misalignment (there is no backfill infiltration). Connection bolts may have moderate corrosion.

Condition State 3: Concrete culvert has extensive deterioration, but the function or structural capacity of the culvert has not been significantly impaired. There may be extensive cracking, scaling, leaching or staining. Structural cracking may be present. Delamination & spalling may be prevalent (exposed rebar may have section loss). Joints may have moderate leakage, separation, offset, or misalignment (there may be minor backfill infiltration). Connection bolts may have severe corrosion (or other distress).

Condition State 4: Concrete culvert has severe or critical deterioration. The function or structural capacity of the culvert has been severely impacted - immediate repairs or structural analysis may be required. There may be severe structural cracking. There may be severe scaling or spalling (exposed reinforcement may have significant section loss). Joints may have severe leakage, separation, offset, or misalignment (there may be significant backfill infiltration). Connection bolts may have failed.

3.6.5 Timber Culvert (Element #242)

This element applies to timber culverts of any type or shape (typically box culverts).

Condition State 1: Timber culvert has little or no deterioration. The barrel has no distortion or deflection. There may be superficial weathering, splitting, cracking, or staining. There is no decay, fire damage, structural distress, or leakage. Connections are secure, members are properly aligned.

Condition State 2: Timber culvert has minor to moderate deterioration. Barrel may have slight deflection or distortion. There may be moderate weathering, cracking, or splitting. There may be minor decay, fire damage, or structural distress. There may be minor leakage, but there is no backfill infiltration. Connections may be slightly loose. Members may be slightly warped, separated, offset or misaligned.

Condition State 3: Timber culvert has extensive deterioration, but the function or structural capacity of the culvert has not been significantly impaired. Barrel may have measurable deflection or distortion. There may be extensive weathering, cracking, or splitting. There may be moderate decay, fire damage, or structural distress (slight crushing or sagging). There may be moderate leakage (or evidence of backfill infiltration). Connections may be loose. Members may be significantly warped, separated, offset or misaligned.

Condition State 4: Timber culvert has severe or critical deterioration. The function or structural capacity of the culvert has been severely impacted - immediate repairs or structural analysis may be required. Barrel may have severe deflection or distortion. Timber members may have severe cracking, fire damage, or structural failure (significant crushing or sagging). There may be severe leakage or backfill infiltration. Connections may have failed. Members may be broken or missing.

3.6.6 Masonry, Other, or Combination Material Culvert (Element #243)

This element includes masonry arch culverts, aluminum box culverts, or any other culvert not adequately described by elements #240, #241, or #242.

Condition State 1: Culvert has little or no deterioration (barrel has no deflection or distortion). Masonry may have superficial weathering (mortar joints are sound). Concrete may have superficial cracking or scale. Steel may have surface corrosion. Aluminum has no corrosion. Joints have no leakage.

Condition State 2: Culvert has minor to moderate deterioration (barrel may have slight deflection or distortion). Masonry may have moderate weathering or cracking (mortar joints may have minor deterioration). Concrete may have moderate scaling or cracking (minor delamination or spalling). Steel may have moderate surface corrosion (minor surface pitting). Aluminum may have minor surface corrosion. Joints may have minor separation, misalignment, or leakage (no backfill infiltration).

Condition State 3: Culvert has extensive deterioration, but the function or structural capacity of the culvert has not been significantly impaired. Barrel may have measurable deflection or distortion. Masonry may have weathering or cracking (mortar joints may have extensive deterioration). Concrete may have extensive scaling, or cracking (delamination or spalling may be prevalent). Steel may have extensive corrosion (measurable section loss). Aluminum may have prevalent surface corrosion (section loss may be present). Joints may have significant separation, misalignment, or leakage (there may be evidence of backfill infiltration).

Condition State 4: Culvert has severe or critical deterioration. The function or structural capacity of the culvert has been severely impacted - immediate repairs or structural analysis may be required. Barrel may have severe deflection or distortion. Masonry may have severe weathering or spalling (mortar joints may have failed). Concrete may have severe cracking, scaling, or spalling. Steel may have advanced corrosion, (severe section loss). Aluminum may have measurable section loss. Joints may have severe misalignment, or leakage (significant backfill infiltration).

3.6.7 Culvert End Treatment (Element #388)

This element applies to culvert headwalls, wingwalls, aprons or other end treatments (any material). The quantity is expressed as an "each" item - on a typical culvert, the quantity will be "2" (one for each end).

Condition State 1: Culvert end treatment has little or no deterioration. Timber may have minor splitting. Steel may have minor surface corrosion. Masonry may have minor weathering (mortar joints are sound). Concrete may have minor cracking or scale.

Condition State 2: Culvert end treatment has minor to moderate deterioration. Timber may have moderate splitting (minor decay or fire damage). Steel may have moderate surface corrosion (minor section loss). Masonry may have moderate weathering (mortar joints may have minor deterioration). Concrete may have moderate cracking or scaling (there may be minor delamination or spalling). End treatment may have slight undermining, settlement, misalignment, or separation.

Condition State 3: Culvert end treatment has extensive deterioration. Timber may have extensive splitting - there may be significant decay or fire damage (slight sagging or crushing). Steel may have extensive corrosion (measurable section loss). Masonry may have extensive weathering (mortar joints may have significant deterioration). Concrete may have extensive cracking or scaling (delamination or spalling may be prevalent). End treatment may have significant undermining, settlement, misalignment, or separation.

Condition State 4: Culvert end treatment has severe deterioration, the function or structural capacity of the culvert has been severely impacted - immediate repairs or structural analysis may be required. Timber may have severe splitting or advanced decay (severe sagging or crushing). Steel may have advanced corrosion (severe section loss). Masonry may have severe weathering (mortar joints may have failed). Concrete may have severe cracking, scaling, delamination, or spalling. End treatment may have severe undermining, settlement, misalignment, or separation.

3.6.8 Culvert Footing (Element #421)

This element applies to culvert footings (typically concrete or masonry footings on arch culverts). This element allows the footings to be rated separately from the remainder of the culvert barrel - it should only be used when the footing is above the ground line (and visible for inspection). This is a "linear ft." item (measured along the length of the culvert barrel). *Note: Element #220 (Reinforced Concrete Footing) should not be used for culverts, as it is classified as a substructure element.*

Condition State 1: Culvert footing has little or no deterioration. Concrete may have minor cracking, leaching, or scaling. Masonry may have minor weathering (mortar joints are sound).

Condition State 2: Culvert footing has minor to moderate deterioration. Concrete may have moderate cracking, scaling or leaching (there may be minor delamination or spalling). Masonry may have moderate weathering (mortar joints may have minor deterioration). There may be slight settlement or undermining.

Condition State 3: Culvert footing has extensive deterioration. Concrete may have extensive cracking, scaling or leaching (delamination or spalling may be prevalent). Masonry may have extensive weathering (mortar joints may have significant deterioration). There may be significant settlement or undermining.

Condition State 4: Culvert footing has severe or critical deterioration. The function or structural capacity of the culvert has been severely impacted - immediate repairs or structural analysis may be required. Concrete may have severe cracking, scaling, delamination, or spalling. Masonry may have severe weathering (mortar joints may have failed - masonry courses may have severe separation or offset). There may be severe settlement or undermining.

3.7 Pontis Smart Flag Elements

"Smart Flag" elements identify conditions or problems present on a bridge that are not adequately addressed by conventional Pontis element language. Smart flags may refer to specific problems that warrant special attention or follow-up action, or may provide detailed information about the condition of specific bridge elements. Mn/DOT currently has eleven Pontis Smart Flag elements…

Element #356: Fatigue Cracking Smart Flag
Element #357: Pack Rust Smart Flag
Element #358: Deck Cracking Smart Flag
Element #359: Underside of Conc. Deck Smart Flag
Element #360: Substructure Settlement Smart Flag
Element #361: Scour Smart Flag
Element #362: Traffic Impact Smart Flag
Element #363: Section Loss Smart Flag
Element #964: Critical Finding Smart Flag
Element #965: Shear Cracking Smart Flag
Element #966: Fracture Critical Smart Flag

While the rating scales for Pontis Smart Flag elements vary, the quantity should always be listed as "1 each" (there is no need to calculate quantities). Most Smart Flag elements are not automatically displayed on the Mn/DOT Bridge Inspection Report - the inspector must determine when they should be added and rated. The exceptions are Smart Flag #964 (displayed on all inspection reports), Smart Flag #361 (displayed on all scour critical bridges), and Smart Flag #966 (displayed on all fracture critical bridges).

3.7.1 Fatigue Cracking Smart Flag (Element #356)

This smart flag only applies to steel elements that serve as primary bridge supports - it should only be used if fatigue cracking is present (cracked tack welds not be considered unless they have propagated into the base metal).

Condition State 1: Fatigue cracking has been arrested (drilled or ground out). Any resultant damage to the steel element has been repaired (the element may still be fatigue prone).

Condition State 2: Fatigue cracking exists and has not been arrested. *Note: this condition state is normally used when fatigue cracking is initially observed, or when additional fatigue cracking is observed (after repairs).*

Condition State 3: Fatigue cracking has seriously damaged a steel bridge element. Immediate repairs or structural analysis may be required.

3.7.2 Pack Rust Smart Flag (Element #357)

This smart flag only applies to steel elements that serve as primary bridge supports - it should only be used if pack rust is present. Pack rust is corrosion between adjacent steel surfaces that results in deformation due to the expansion of oxidized steel. Pack rust is commonly found on truss connections, splice plates, and along the edge of built-up riveted members. Pack rust may eventually result in the failure of pins, rivets, bolts, or welds. *Note: pack rust typically indicates the presence of section loss.*

Condition State 1: Pack rust has started to form on a steel element or connection (rust staining is evident along the edges or seams).

Condition State 2: Pack rust has started to distress a steel element or connection (there may be minor spreading, swelling, or scalloping).

Condition State 3: Pack rust has resulted in significant distress to a steel element or connection. There may be significant spreading, swelling, or scalloping - steel members may be significantly deformed or distorted. However, all connectors (pins, rivets, or bolts) remain intact.

Condition State 4: Pack rust has resulted in severe distress to a steel element or connection. Immediate repairs or structural analysis may be required. Steel members may be severely deformed or distorted, or connectors (pins, rivets, or bolts) may have failed.

3.7.3 Concrete Deck Cracking Smart Flag (Element #358)

This smart flag is used to rate the extent and severity of cracking in concrete wearing surfaces - if the deck has a bituminous or gravel wearing surface, there is no need to use this smart flag. Cracking of the wearing surface will eventually result in chloride contamination of the underlying concrete deck, and corrosion of the reinforcing steel. This smart flag can be used to track preventative maintenance (crack sealing), which can increase the service life of the deck. The condition state language for this smart flag is below is based upon the following general definitions…

> ***Crack Width:*** *"insignificant cracks" are those too narrow to practically measure, "moderate cracks" are those large enough to measure, and "severe" cracks are those greater than ¼**"** in width (or otherwise deemed "severe" by the judgment of the inspector).*
>
> ***Crack Density:*** *"minor" crack density is an approximate spacing of 10 ft. or greater, "moderate" density is a spacing of 5-10 ft., and "severe" density is a spacing of 5 ft. or less (or otherwise deemed "severe" by the judgment of the inspector).*

Condition State 1: Cracks in the concrete wearing surface are sealed or insignificant in size and density.

Condition State 2: Concrete wearing surface has unsealed cracks of moderate size ***or*** density.

Condition State 3: Concrete wearing surface has unsealed cracks of moderate size ***and*** density.

Condition State 4: Concrete wearing surface has unsealed cracks of severe size ***and/or*** density.

3.7.4 Underside of Concrete Deck Smart Flag (Element #359)

<u>This smart flag must be rated for all bridges with a concrete deck or slab</u> (even if the underside of the deck is concealed by stay-in-place forms). This smart flag should typically not be used for bridges with an integral superstructure & deck (such as precast channels, prestressed tees, or prestressed voided slabs).

Note: "Distressed area" refers to the total area (on the underside of a concrete deck or slab) with leaching (efflorescence), salt/ water saturation, rust stains, delaminations, spalls, temporary repair patches, or other significant deterioration. On decks with stay-in-place forms, areas with corrosion, leaching, or other significant deterioration should be considered to be "distressed".

Condition State 1: Underside of the concrete deck (or slab) has little or no distress. There may be superficial cracking or light leaching. Stay-in-place forms have no corrosion.

Condition State 2: The total "distressed area" on the underside of the concrete deck (or slab) is 2% or less of the total deck area.

Condition State 3: The total "distressed area" on the underside of the concrete deck (or slab) is more than 2%, but not more than 10% of the total deck area.

Condition State 4: The total "distressed area" on the underside of the concrete deck (or slab) is more than 10%, but not more than 25% of the total deck area. There may be impending full-depth deck failures - structural underpinning may be present (or required).

Condition State 5: The total "distressed area" on the underside of the concrete deck (or slab) is more than 25% of the total deck area. There may be full-depth deck failures - structural underpinning may be present (or required).

3.7.5 Substructure Settlement & Movement Smart Flag (Element #360)

This smart flag only applies to bridge substructure elements (piers, abutments, or wingwalls) that show evidence of settlement, movement, or rotation. It is intended to identify bridges that are experiencing settlement and to provide some measure of the magnitude of that settlement.

Condition State 1: Substructure elements have visible settlement, movement or rotation. The settlement has been arrested, appears to have stabilized, or is minor.

Condition State 2: Substructure elements have continuing settlement, movement or rotation. If not arrested, this could adversely impact the structural integrity of the bridge.

Condition State 3: Substructure elements have severe settlement, movement or rotation - structural analysis may be warranted.

3.7.6 Scour Smart Flag (Element #361)

This smart flag is intended to identify bridges that are experiencing scour (or have a history of scour problems) and to provide some measure of the magnitude of scour. This smart flag also identifies bridges that are scour critical, or require scour monitoring during high water events. *Note: if the Mn/DOT Scour Code is listed as D, G, K, O, P, R or U, this smart flag will automatically be added.* During each routine inspection, substructure components that are submerged in water should be investigated for scour by wading and probing. If the channel is too deep for wading, the underwater inspection report should be reviewed to determine the condition rating for this smart flag.

Condition State 1: Scour exists, but is of little concern to the structural integrity of the bridge. *Note: bridges with a Mn/DOT Scour Code of D, G, K, O, P, R or U can be rated as condition 1, even if no scour is currently present at the bridge site.*

Condition State 2: Scour exists that, if left unchecked, could adversely impact the structural integrity of the bridge.

Condition State 3: Scour exists that is significant enough to warrant analysis of the structure.

3.7.7 Traffic Impact Smart Flag (Element #362)

This smart flag applies to primary structural bridge elements (typically superstructure) that have traffic impact damage. While this typically refers to damage from high loads, it can include impact damage from other causes (flood debris, ice dams, etc.). The inspector should note any recent (or previously un-recorded) damage, and note any repairs. This smart flag should remain even after repairs have been made to provide a history of impact damage to the structure. *Note: This smart flag does not apply to damaged railings or guardrail.*

Condition State 1: Impact damage has been repaired (superficial damage may be present). Steel members have been straightened and/or reinforced. Concrete members have been patched (there is no exposed reinforcement or tensioning cables).

Condition State 2: Impact damage has occurred, but the structural integrity of the element (or bridge) has not been significantly reduced. Steel members may be bent out of plane. Concrete members may be spalled (exposed reinforcement or tensioning cables are still intact).

Condition State 3: Impact damage has occurred and the strength of the member is impaired. Analysis is warranted to ascertain the serviceability of the bridge.

3.7.8 Section Loss Smart Flag (Element #363)

This smart flag only applies to primary steel bridge elements that have section loss due to corrosion. Section loss is typically expressed as a percentage of the total cross-section area of the member (the percentages in the rating descriptions are included as a general guideline). *Note: the presence of flaking rust or pack rust indicates that at least some section loss is present.*

Condition State 1: Steel element has minor section loss (less than 2% of the total cross-section area). If the steel element has been recently repainted, any previously existing section loss has been reinforced (or is less than 5% of the total cross-section area).

Condition State 2: Steel element has moderate section loss (from 2% to 5% of the total cross-section area). If the steel element has been recently repainted, any previously existing section loss is not severe enough to warrant structural analysis (less than 10% of the effective section).

Condition State 3: Steel element has significant section loss, but structural analysis is not yet warranted (section loss is less than 10% of the total cross-section area) or structural analysis has determined that the existing section loss has not significantly reduced the structural integrity of the element.

Condition State 4: Steel element has severe section loss (more than 10% of the total cross-section area). The load-carrying capacity of the element has been significantly reduced - structural analysis or immediate repairs may be required.

3.7.9 Critical Finding Smart Flag (Element #964)

This smart flag indicates if a critical finding was observed during the inspection. A critical finding (or deficiency) is any structural condition that, if not promptly corrected, could result in collapse (or partial failure) of the bridge. This does not include safety-related problems (such as damaged railings, guardrails, etc.) - while such hazards should be reported and addressed promptly, they are not expected to result in collapse of the bridge, and are not considered to be critical findings.

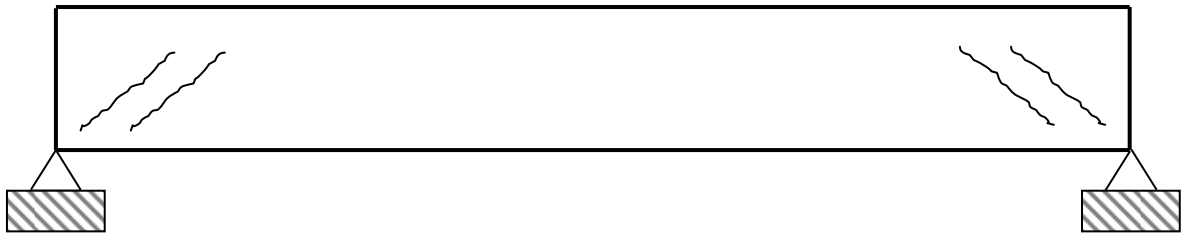
Note: this smart flag must be included and rated on all bridge inspection reports - Mn/DOT Technical Memorandum TM-05-02-B-02 outlines the reporting and follow-up procedures for a critical finding.

Condition State 1: No critical findings were observed during the inspection.

Condition State 2: A critical finding was observed during the inspection. *The condition should be thoroughly documented, and the Engineer (and Bridge Owner) must be notified immediately. It may be necessary to restrict traffic until further evaluation can be made or until the situation is corrected.*

3.7.10 Concrete Shear Cracking Smart Flag (Element #965)

This smart flag only applies to reinforced concrete or pre-stressed concrete superstructure elements with existing shear cracks. Shear cracking can result form inadequate shear reinforcement, and typically appear as diagonal cracks near the supports (inclined towards the center of the span).



Condition State 1: Shear cracking is present, but the cracking is isolated and minor (hairline).

Condition State 2: Shear cracking may be present in several locations, but the cracking is minor (no measurable offset along the crack). Minor leaching or rust staining may be present along the cracks.

Condition State 3: Shear cracking may be widespread or significant (measurable offset along the crack). Extensive leaching or rust staining may be present along the cracks. However, the structural integrity of the bridge has not been significantly reduced. Any severe shear cracks have been repaired and/or reinforced.

Condition State 4: Shear cracking is severe (significant offset along the crack). Shear cracking may be severe enough to reduce the structural integrity of the bridge. Immediate repairs or structural analysis may be required.

3.7.11 Fracture Critical Smart Flag (Element #966)

This smart flag identifies those bridges classified as "fracture critical". The intent of this smart flag is to insure that that all fracture critical members are visually examined during each routine inspection, and to identify problems discovered between "in-depth" inspections. Refer to the plans (or the fracture critical report) to identify the fracture critical members. *Note: A "fracture critical" bridge has at least one fracture critical member (a steel tension member whose failure would be expected to result in collapse of the bridge). Only bridges carrying vehicular traffic are considered to be "fracture critical" (pedestrian and railroad bridges are excluded).*

Condition State 1: Bridge is "fracture critical" - all fracture critical members are structurally sound (no significant damage or deterioration).

Condition State 2: Bridge is "fracture critical" - fracture critical member(s) have damage or deterioration, but the members have either been repaired or structural analysis has determined that the member is stable for the anticipated loading (the bridge may have been posted with a load restriction).

Condition State 3: Bridge is "fracture critical" - damage or deterioration to fracture critical members warrants structural analysis or immediate repairs.

3.8 Other Pontis Bridge Elements

These elements were added by Mn/DOT to rate the condition of bridge items not addressed by the CoRe elements. The quantity can be listed as "1 each".

3.8.1 Signing (Element #981)

This element applies to any signing mounted on, or any signing related to the bridge. This can include load posting signs, vertical or horizontal clearance signs, object (hazard) markers, speed limit signs, plow markers, advance warning signs, informational signs, changeable message signs, etc. *Note: this element will be automatically added if the structure inventory indicates that signage is required. <u>The actual load posting (Tons) and/or posted vertical clearance (Feet/Inches) should be noted on the inspection report.</u>*

Condition State 1: All required signing is present and is in good condition (there may be superficial damage or deterioration).

Condition State 2: All required signing is present - signs may have some damage or deterioration (slightly bent or faded), but remain readable.

Condition State 3: Signing *(excluding vertical clearance or load posting signage)* is absent, or existing signing is damaged or deteriorated to the extent that repair or replacement is required.

Condition State 4: *Required vertical clearance signing is absent, incorrect, or existing signing is damaged or deteriorated to the extent that repair or replacement is required.*

Condition State 5: *Required load posting signing is absent, incorrect, or existing signing is damaged or deteriorated to the extent that repair or replacement is required.*

3.8.2 Approach Guardrail (Element #982)

This element rates the condition of guardrail above or below the bridge. This includes all types of guardrail (plate beam or cable), as well as guardrail end treatments and crash attenuators. *Note: if guardrail is absent (and should be installed), this element could be rated as "3".*

Condition State 1: All required guardrail is present, is in good condition, and is functioning as intended to protect vehicles from impacting the bridge.

Condition State 2: Guardrail may have moderate damage or deterioration, but is still functioning as intended to protect vehicles from impacting the bridge.

Condition State 3: Guardrail has severe damage or deterioration - repair or replacement is required (possible traffic hazard).

3.8.3 Plowstraps (Element #983)

Plowstraps (or "plow fingers") are small steel plates welded to expansion joints to prevent snowplow damage to the joint - they are common on strip seal expansion joints.

Condition State 1: All required plowstraps are present.

Condition State 2: Some plowstraps are missing and need replacement.

Condition State 3: Most plowstraps are missing and need replacement.

3.8.4 Deck & Approach Drainage (Element #984)

This element rates the condition, function, and adequacy of the drainage system. This includes drainage of the deck and approaches, and can include areas adjacent to (or below) the bridge. This includes items such as deck drains, inlets, scuppers, grates, drain troughs, downspouts, catch basins, spillways, splash aprons, ditches, or holding ponds. *Note: downspouts should extend far enough to prevent runoff from falling onto the superstructure.*

Condition State 1: Drainage system is in good condition and functioning as intended. There is no notable ponding or drainage-related slope erosion.

Condition State 2: Drainage system is inadequate or is not functioning properly. The drainage system may be clogged with debris - flushing or cleaning may be required. There may be ponding on the deck, approaches, or below the bridge. Runoff may be contributing to slope erosion or deterioration of bridge elements. Drainage components may be damaged or deteriorated, but remain intact.

Condition State 3: Drainage system has failed - repairs are required. Severe ponding may present a traffic hazard. Runoff may have resulted in severe slope erosion (or significant deterioration of bridge elements). Drainage components may be disconnected, missing, or severely deteriorated.

3.8.5 Slopes & Slope Protection (Element #985)

This element rates the condition of the slopes and slope protection - this includes unprotected (bare dirt) slopes. This can include the slopes in front of abutments, abutment side slopes, slopes around piers, or culvert embankments. Slope protection may consist of concrete, bituminous-coated aggregate, loose

riprap, grouted riprap, gabions, revet mattresses, or any material intended to protect the slope from erosion. *Note: slope erosion may be related to deck drainage or scour - the inspector should attempt to determine the cause of any slope erosion.*

Condition State 1: Slopes are in good condition - there is no notable erosion. Substructure is adequately protected (no exposure of footings or pilings). Slope protection (if present) may have superficial deterioration (there is no notable settlement, heaving, or undermining).

Condition State 2: Slopes may have minor to moderate erosion. Footings (or pilings) may be slightly exposed, but there is no significant undermining or loss of backfill. Slope protection (if present) may have moderate deterioration - there may be settlement, heaving, or undermining.

Condition State 3: Slopes may have severe erosion - repairs are required. Footings may be significantly undermined - there may be significant loss of backfill. Slope protection (if present) may be severely deteriorated - there may be significant settlement, heaving, or undermining.

3.8.6 Curb & Sidewalk (Element #986)

This element rates the condition of the sidewalk and curb on the bridge (or approaches). This generally does not apply to a sidewalk running below the bridge.

Condition State 1: Sidewalks and curbs are in good condition - there may be minor (superficial) damage or deterioration.

Condition State 2: Sidewalks and/or curbs have moderate damage or deterioration. Concrete may have cracking, spalling, or delamination. Timber may have cracking, splitting or decay.

Condition State 3: Sidewalks and/or curbs have severe damage or deterioration (repairs are required).

3.8.7 Roadway over Culvert (Element #987)

This element rates the condition of the roadway running above a culvert. 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 centerline of the culvert. On rigid (concrete) culverts, look for cracking and settlement along the edges of the culvert. This element can also be used to rate the condition of roadways on filled spandrel arch bridges or running through tunnels.

Condition State 1: Roadway above culvert is in good condition. The paving may have minor cracking, but there is no settlement.

Condition State 2: Roadway above culvert has moderate cracking (or other deterioration). There may slight settlement.

Condition State 3: Roadway above culvert has severe cracking (or other deterioration) - there may be significant settlement.

3.8.8 Miscellaneous Items (Element #988)

This element can be used to rate the condition of any bridge feature not adequately described by the other elements (such as lighting or utilities). This element can also be used to address maintenance needs (such as flushing, tree trimming or graffiti).

Condition State 1: Minor damage or deterioration.

Condition State 2: Moderate damage or deterioration.

Condition State 3: Severe damage or deterioration - repairs may be required.

Appendix: Bridge Components & Structure Types

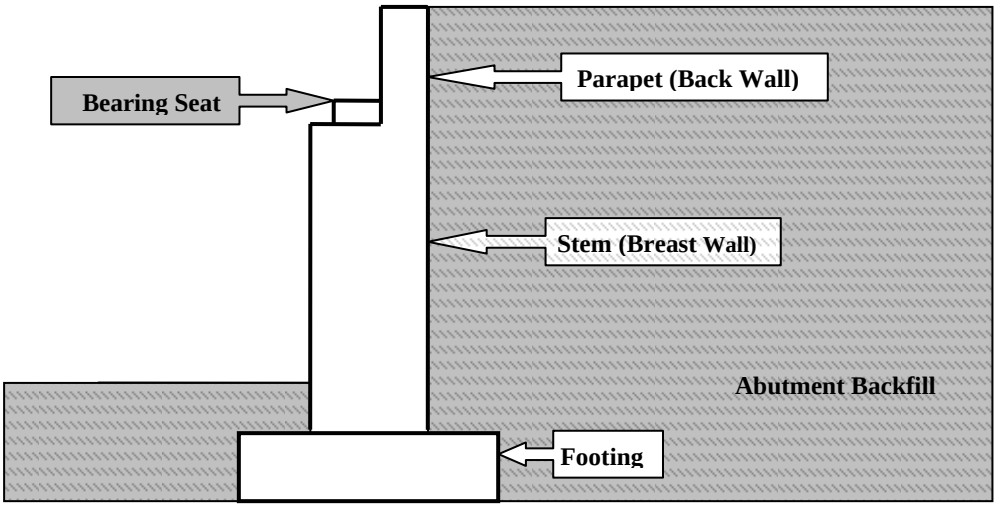
Note: This appendix is incomplete - it will eventually include general inspection procedures and condition rating guidelines for common bridge superstructure type, this will essentially be a condensed version of the guidelines in the Bridge Inspector's Reference Manual (BIRM).

A.1 Substructure Components

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

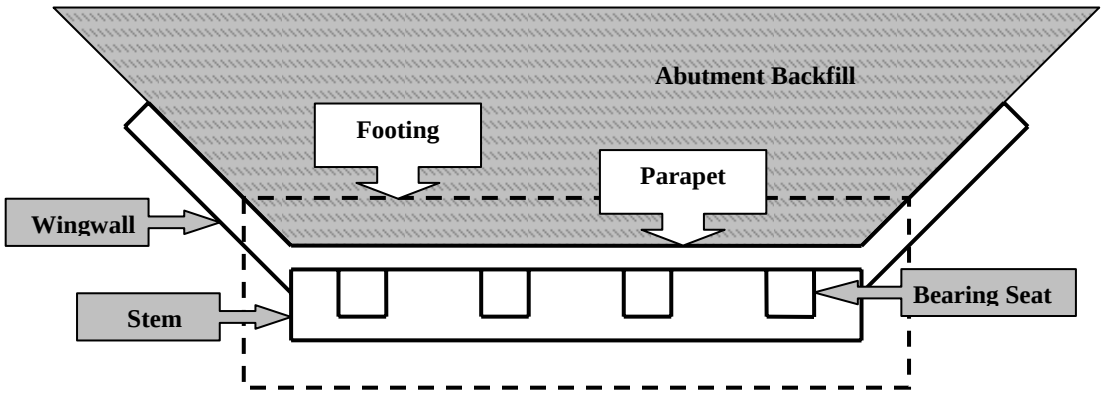
A.1.1 Condition Rating Procedures for Abutments

Components of a Concrete Abutment: Most abutments are constructed of reinforced concrete - while the overall configuration will vary, most concrete abutments share these typical components…



Cross-section (side view) of a Typical Concrete Abutment

- **Stem:** The abutment stem (or breast wall) is the primary component of the abutment - it transmits the load of the bridge superstructure to the footing, and retains the abutment backfill.
- **Bearing Seat:** The bearing seat provides a horizontal bearing area for the superstructure.
- **Parapet:** The parapet (or back wall) prevents backfill soil from sliding onto the bearing seat, and provides support for the deck expansion joint (or approach slab).
- **Footing:** 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, or may transfer these loads directly to the supporting soil or rock ("spread footing").
- **Wingwall:** A wingwall is typically a short retaining wall extending from each end of the abutment which is intended to retain the side slope. The wingwall configuration will vary according the height of the abutment and the site conditions.



Plan View of a Typical Concrete Abutment

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 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 Rating Procedures 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. The condition rating descriptions for reinforced concrete elements are outlined in Section 3.4.3.

- Element #215 (Reinforced Concrete Abutment) should be used to rate the abutment stem, seat, and parapet). This is a “linear foot” item - the quantity is determined by measuring horizontally across the front face of the abutment (excluding the wingwalls).

- Mn/DOT has added element #387 (Reinforced Concrete Wingwall) to rate the wingwalls. This is an “each” item (a single condition state must be determined for each wingwall) - the quantity will typically be “4” (one wingwall at each corner).

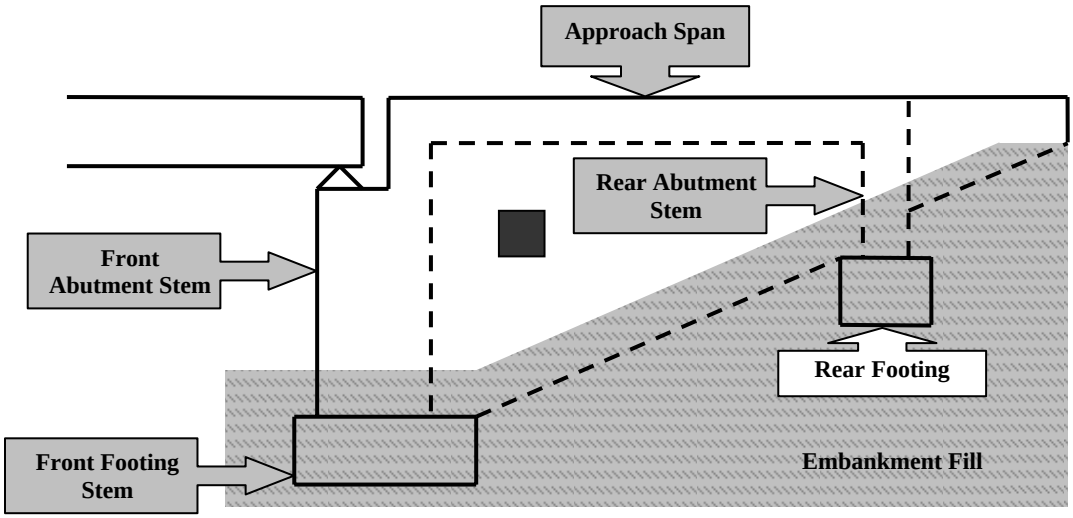
- As the footings (and pilings) supporting a concrete abutment are typically not visible for inspection, they are typically not rated. If the abutment footing is visible for inspection, it can be rated using element #220 (Reinforced Concrete Footing) - this is an “each” item.

- If settlement, rotation, or other movement of the abutment is evident, the Settlement Smart Flag (element #360) must be rated accordingly (see Section 3.7.5). If scour is present, the Scour Smart Flag (element #361) must be rated accordingly (see Section 3.7.6).

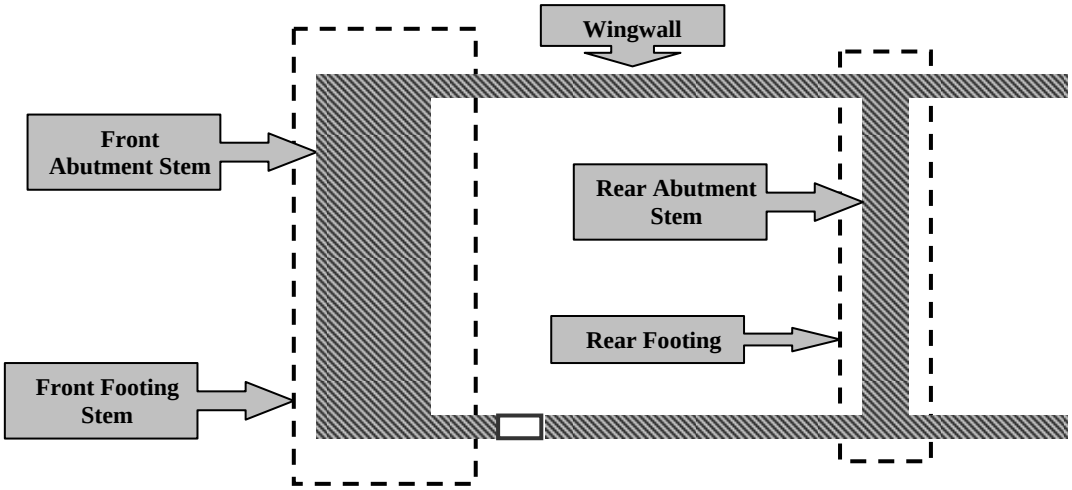
- Element #985 (Slopes & Slope Protection) should be used to rate the condition of the abutment slopes (and slope protection, if any).

Hollow Concrete Abutments: Hollow "U-Type" concrete abutments are actually an enclosed approach span (typically a cast-in-place concrete T-girder or slab span). The wingwalls enclose the sides of the span, creating a "hollow" abutment that appears to be solid (access hatches are typically located on the wingwalls or parapets). These are designed to reduce the dead load (as opposed to a solid abutment) and subsequent settlement of the abutment. *Note: periodic internal inspections are required to assess the condition of the interior elements - confined space entry procedures may be required.*

Element #215 (Reinforced Concrete Abutment) should be used to rate the front abutment stem (including the seat and parapet) as well as the rear abutment stem - the LF quantity will be twice that of conventional abutment. Element #387 (Reinforced Concrete Wingwall) should be used to rate the condition of the sidewalls. An element must also be selected to rate the enclosed approach span - depending upon the span type, this may include beam, deck, or slab elements.

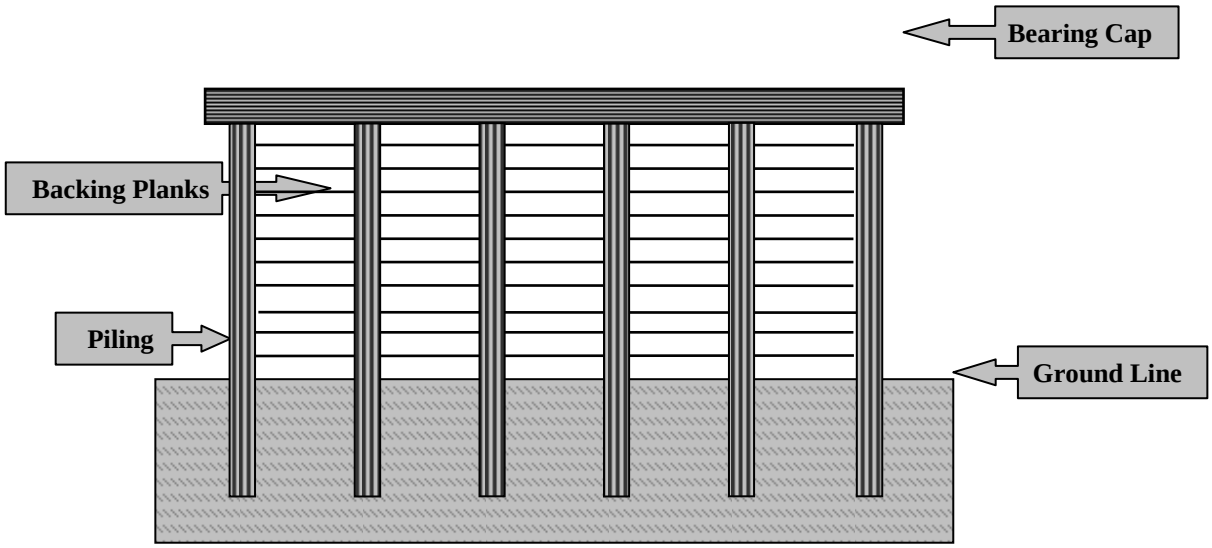


Elevation View of a Hollow Concrete Abutment



Section View (Looking Down) of a Hollow Concrete Abutment

Condition Rating Procedures for Timber Abutments: Timber abutments are typically comprised of three main components (backfill planks, bearing cap, and piling), which are rated using separate Pontis elements. These components may be connected with bolts, lag screws, nails, spikes, or drift pins (cap to piling connections are often reinforced with steel straps). The inspector should determine the condition of each element (see Section 3.4.5 for timber element rating descriptions), 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, the settlement smart flag (element #360) should be appropriately rated.*



Front View of a Typical Timber Abutment

- **Backfill Planks:** The backfill planks retain the abutment backfill and transfer the earth pressure forces to the piling - they should be inspected for bulging, gaps, or voided backfill. Element #216 (Timber Abutment) should primarily reflect the condition of the backfill planks, but should also reflect the overall structural condition of the abutment. This is a linear ft. item (measured along the front face of the abutments (excluding the wingwalls).

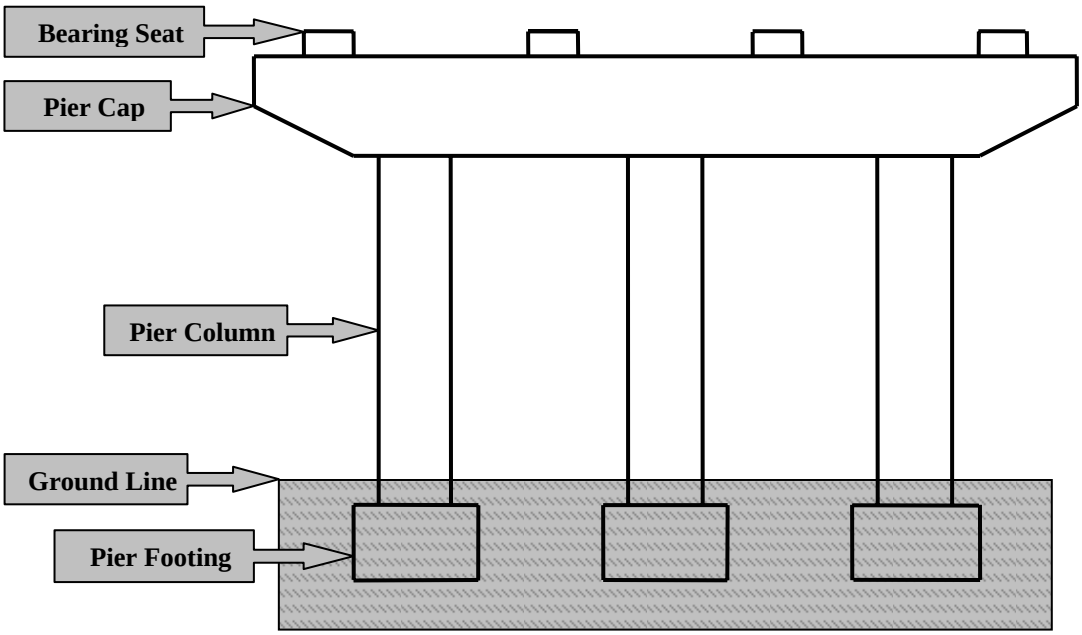
- **Bearing Cap:** The bearing cap provides a bearing seat for the superstructure, and transfers the superstructure loads to the piling. Element #235 (Timber Pier Cap) should be used to rate the condition of the abutment bearing cap. This is a "linear ft." item (measured along the length of the cap) - the total element quantity should include the pier caps (if any). *Note: If the cap is comprised another material (such as steel or concrete), the appropriate cap element should be selected.*

- **Piling:** The piling transmit the superstructure load to the supporting soil. To resist the horizontal force resulting from earth pressure, abutment piling may incorporate steel cable tie-back systems. Element #228 (Timber Piling) should be used to rate the condition of the abutment piling. This is an "each" item - the total element quantity should include the pier piling (if any), but not the wingwall piling. *Note: If the piling are comprised another material (such as steel or concrete), the appropriate piling element should be selected.*

- **Wingwalls:** Mn/DOT has added element #386 (Timber Wingwall) to rate the wingwalls, the quantity is expressed as an "each" item - on a typical bridge, this quantity will typically be "4" (one wingwall at each corner). The wingwall piling can be included in this element (there is no need to include them in the total piling quantities).

A.1.2 Condition Rating Procedures for Piers

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



Typical Concrete "Column Pier" Configuration

- **Pier Cap:** The pier cap is the upper horizontal portion of the pier that supports the superstructure - they are subjected to bending and shear forces. The pier cap (including the bearing seats) is rated using element #234 (Reinforced Concrete Cap) - this is a "linear foot" quantity (measured along the length of the cap).

- **Pier Columns:** The vertical pier columns transfer the superstructure load from the pier cap to the pier footing - they are primarily subjected to compression forces. Pier columns are rated using element #205 (Reinforced Concrete Column) - this is an "each" item, a single condition rating must be determined for each column. If there are protective crash struts (or barriers) between the pier columns, they can be rated using element #380 (Secondary Structural Elements) - this is an "each" item, the quantity can simply be left as "1" (there is no need to add them up them).

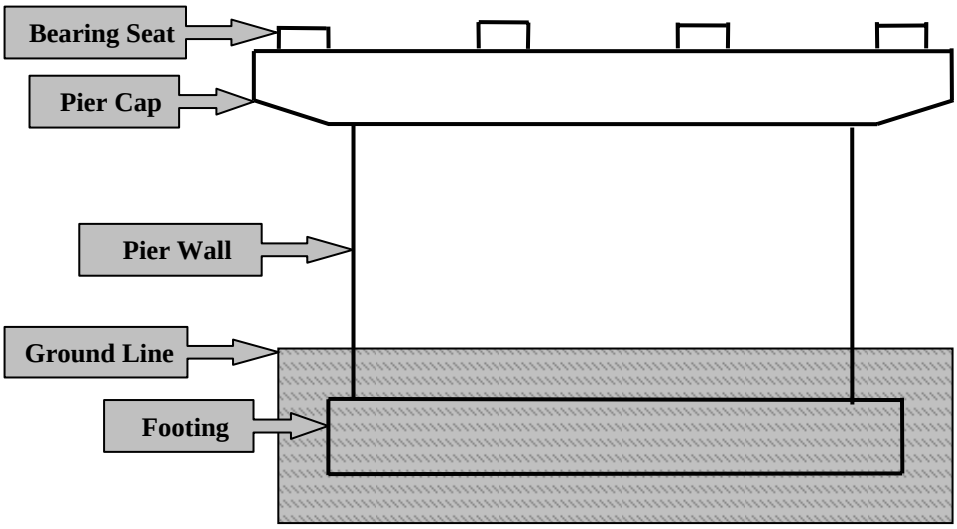
- **Pier Footings:** As pier footings are typically below grade and not visible for inspection, they are typically not rated.

Inspection Procedures for Concrete Piers:

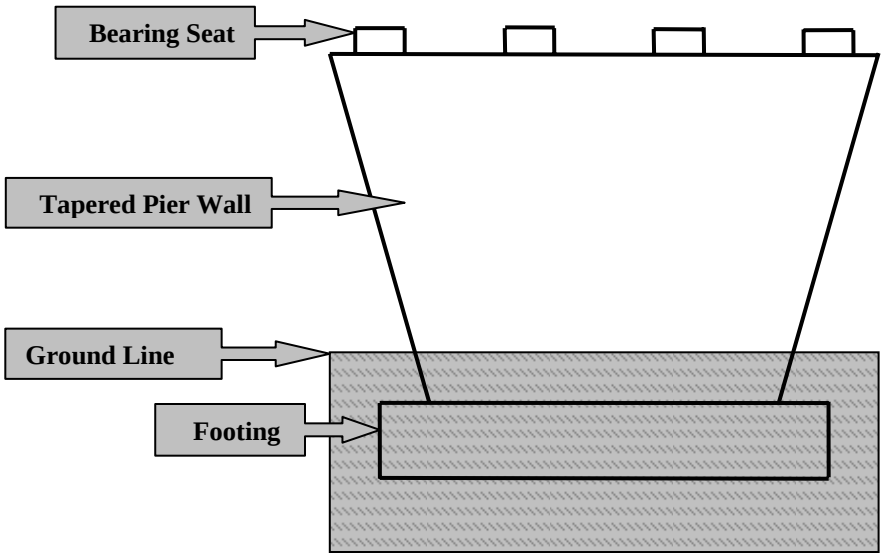
- Note any concrete deterioration (cracking, leaching, rust staining, delamination or spalling).
- Note any evidence of deck joint leakage (staining on the cap or debris on the bearing seat).
- Note any evidence of settlement, tipping, rotation, or other movement.
- If the pier is submerged in water, the perimeter of the pier 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 pier protection components (such as dolphins, fenders, or crash struts).

Concrete Pier Walls: Another common reinforced concrete pier configuration is a "pier wall", which is supported by a solid shaft (instead of separated columns) - the shaft may be straight (vertical) or tapered. Element #210 (Reinforced Concrete Pier Wall) should be used to rate any pier supporting element that is 10 ft. or greater in width. This is a "linear ft." quantity (measured horizontally along the face of the pier wall (on tapered pier walls, use the widest dimension).

A pier wall may or may not include a pier cap. If a pier cap is present, element #234 (Reinforced Concrete 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 typically not rated.



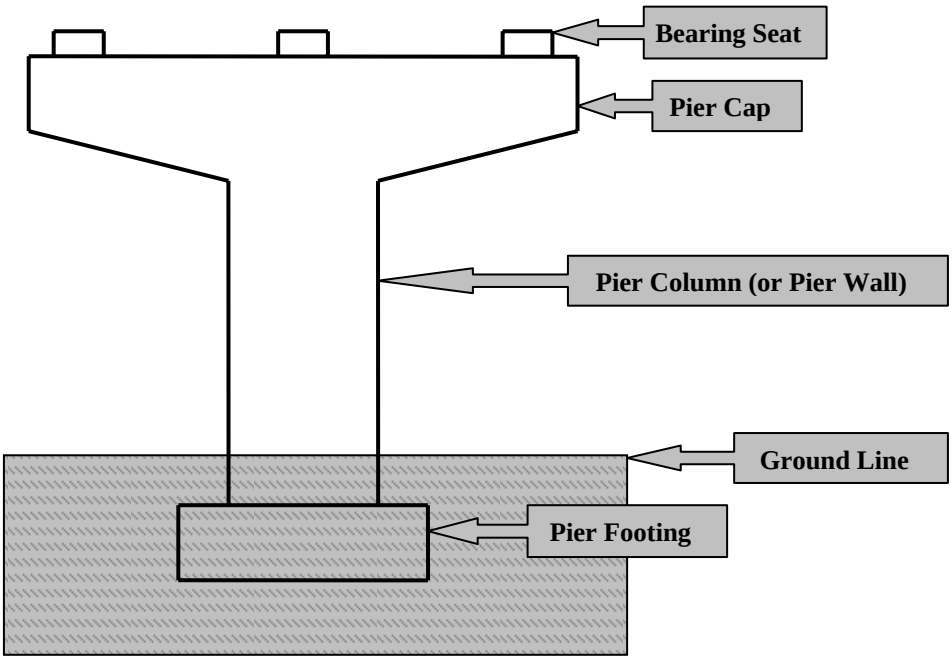
Concrete Pier Wall - Straight (Vertical) Shaft with Pier Cap



Concrete Pier Wall - Tapered Shaft without Pier Cap

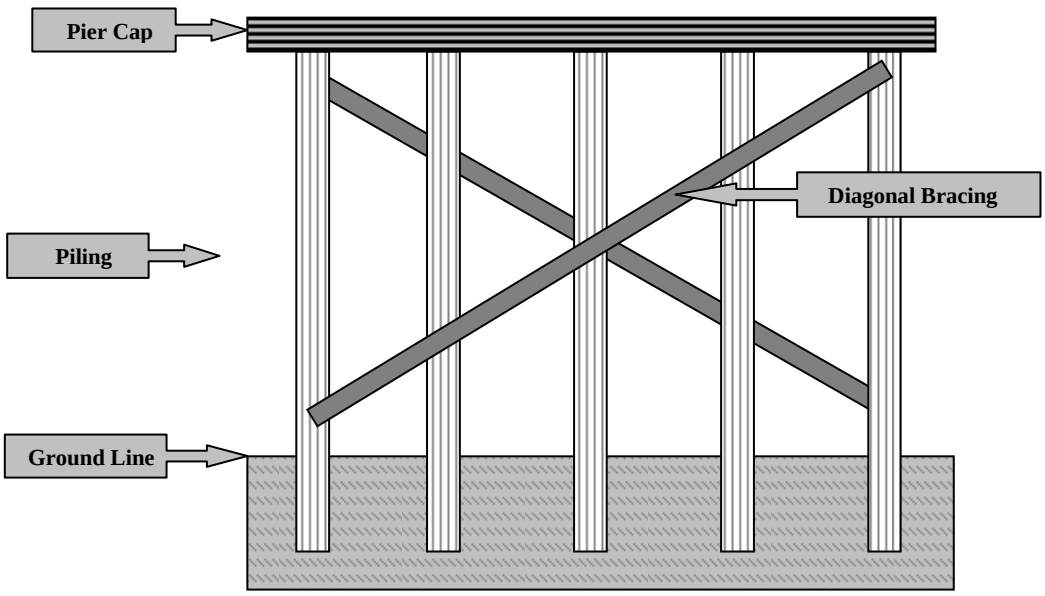
Hammerhead Pier: A “hammerhead pier” consists of a single column with a relatively wide cantilevered pier cap. Element #234 (Reinforced Concrete Cap) should be used to rate the cap and bearing pedestals - this is a “linear foot” quantity (measured along the length of the cap). The cantilever portion of the cap should be examined for any evidence of structural distress (such as shear cracking).

Element #205 (Reinforced Concrete Column) will typically be used to rate the column - this is an “each” item. However, 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 “linear foot” item. As pier footings are typically below grade and not visible for inspection, they are typically not rated.



Typical “Hammerhead” Pier Configuration

Pile Bent Piers: Piers comprised of two or more piling supporting a pier cap are known as pile bents - while these are 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. *Note: If the pier has tipped, settled, or moved the settlement smart flag (element #360) should be appropriately rated.*



Pile Bent Pier

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). If the piling are submerged in water, the adjacent stream bottom should be probed for evidence of scour (refer to the underwater inspection report, if applicable). Mn/DOT six piling elements - they are all “each” items, a single condition rating must be determined for each pile.

- Element #225: Unpainted (Weathering) Steel Piling
- Element #226: Prestressed Concrete Piling
- Element #227: Reinforced Concrete Piling
- Element #228: Timber Piling
- Element #382: CIP (Cast-in-place) Piling
- Element #419: Painted Steel 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. On a pile bent pier, the cap will typically be rated using element #230 (Unpainted Weathering Steel Pier Cap, element #231 (Painted Steel Pier Cap), element #234 (Reinforced Concrete Pier Cap), or element #235 (Timber Pier Cap). These are linear ft. items (measured along the length of the cap) - the total element quantity should include the abutment bearing caps (if any).

Pier Bracing: To prevent buckling, timber pier pilings are often reinforced with diagonal bracing - these should be examined for deterioration, impact damage, or connection failure. Bracing members can be rated using element #380 (Secondary Structural Elements) - this is an “each” item, the quantity can simply be left as “1” (there is no need to count up the separate members).