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Chapter 2 - Condition Evaluation of Bridges for Iowa DOT Personnel

CHAPTER 2
CONDITION EVALUATION OF BRIDGES FOR IOWA DOT PERSONNEL

The purpose of this chapter is to provide safety inspection guidance to Iowa DOT program managers, team leaders, and inspectors to ensure that all NBIS requirements detailed in the 2022 SNBI (per 23 CFR Part 650, Subpart C) are met for the 4,000 plus bridges that the DOT owns, inspects, and maintains. This includes aspects of inspection planning, preparation, permitting (if required), access planning and documentation preparation. Both appraisal and condition coding instruction and guidance per SNBI and the MBIE are provided. Section 2.4 provides general inspection procedures for deck, superstructure, substructure, channel, and culvert inspections. The use of various modules comprising Iowa's Structure Inventory and Inspection Management System (SIIMS) is discussed. Required supporting documentation such as photographs, sketches, plans, and other documents are described in section 2.5.7. Section 2.5 concludes with requirements for the Critical Finding process, load rating documentation, Maintenance, Repair and Recommendations (MR&R), the inspection report and report information. Instructions for entering Program Recommendations in SIIMs for work that cannot be done by District forces is provided and this chapter concludes with a listing of the many identifying characteristics of Features that are both on and under the bridge required by the SNBI.

Note that safety inspection guidance for the 19,000 plus Local Public Agency (LPA) owned bridges is provided in Chapter 4.

2.1 INSPECTION PLANNING

2.1.1 Reviewing Past Inspection Reports, SIIMS Data, Existing Bridge Plans, and Bridge Repair Plans

The first step in preparing for any bridge inspection for bridges on the Iowa DOT State or U.S. highway system is to gather information regarding the existing bridge so the inspector is informed about the configuration and type of bridge as well as its documented history. Understanding the details of the existing bridge is essential to ensure that the number of inspection personnel and type of equipment and tools, including non-destructive testing equipment, needed to perform the inspection can be determined. When as-built plans and plans for any repairs or rehabilitation projects are available, the inspector must review the plans for a complete understanding of the bridge configuration and structure type. Reviewing the plans will allow the inspector to plan ahead for the access requirements that might affect how the bridge will be inspected. Typically, if existing plans are available, they would be included as part of the bridge's record within the SIIMS database. Another helpful resource is any available shop drawings produced by the contractor or the contractor's fabricators at the time the bridge was initially built or rehabilitated. If there are no drawings or even a load rating sketch available, it will be necessary to generate bridge sketches to include framing, cross sections, substructure, and other elements as needed to be able to verify or code new SNBI inventory information.

In addition to existing plans and shop drawings, the bridge record within SIIMS must also contain past inspection reports for the bridge. Reviewing these past reports not only helps the inspector identify problem areas of the bridge that were previously documented but also allows the inspector to document and discuss the progression of damage or deterioration over the course of multiple inspections. This also helps the inspector to identify deterioration trends and potential future problem areas. The inspection reports should also include photographs and field sketches documenting the condition of the bridge.

2.1.2 Determining Required Inspection Documentation and Preparing Needed Sketches

While reviewing the available information for the bridge, the inspector will begin to develop an understanding of the bridge. During this review, the inspector must decide if it is necessary to prepare sketches or tables in advance to be used for documenting current conditions to be more efficient in the field and to record crucial inspection findings more clearly. The inspector must decide if the previous report documentation was sufficient to convey the bridge's condition and support SNBI Condition Ratings, as well as NBE Conditions States. For example, before going into the field for the bridge inspection, the inspector must decide if a table would be best to record bearing movement, expansion joint movement data, clearances, or probing/scour measurements. Sketches may be a better choice for recording crack locations and sizes for the underside surface of the bridge deck or for individual piers or abutments, based on available data. Sections 2.4 and 2.5 provide details on what conditions trigger the need for sketches, tables, or photos. In general, if previous sketches or tables are available and legible, updating those sketches in the field can save time on inspection.

2.1.3 Arranging for Access and Other Inspection Equipment

A critical component of any bridge inspection preparation is determining how to access the bridge components during the inspection. In addition, depending on the type of inspection and nature of the bridge components, such as whether the bridge includes NSTM components requiring arm's-length access, the access requirements may require more rigorous planning.

Depending on the type of inspection, size of the bridge, and its height above ground level, inspection access could be as simple as ground-level observations. Frequently, ladders, a UBIV, a manlift, or even rope access techniques will be necessary to access key bridge components properly. However, developing an access plan requires careful consideration of several elements:

- Components to be inspected
- Topography and features crossed by the bridge that might limit access options
- Whether traffic interruptions can be tolerated
- Load restrictions on the bridge
- Geometry of the bridge and its sidewalks, bridge rails, and fencing
- Review of whether certain access methods may provide a cost advantage by saving time and labor even at the expense of the equipment costs or rental.

If it is determined that a manlift or UBIV is required to access the bridge components for inspection, advance planning is required to either schedule the equipment, if State-owned, or to determine availability and rent the equipment from an outside source. A variety of UBIV options are available that allow the vehicle reach and the number of rotating turrets to be tailored to the specific constraints of the bridge to be inspected. This may be especially critical for truss bridges, where the ability to maneuver the boom of a UBIV through and between truss members may be dependent on the configuration of the UBIV. The inspector will use SNBI Item B.IE.12 to record the access equipment used for the inspection.

2.1.4 Arranging for Advanced Bridge Washing

The previous inspection report must be reviewed for presence of debris, animal nesting materials, and bird droppings to then coordinate with the Iowa district maintenance personnel to determine if the bridge needs washing prior to inspection. Inspections scheduled during winter months may not allow advanced bridge washing due to freezing conditions. Additionally, some environmental regulations may limit periods when active nests of migratory birds, such as swallows, may be removed.

2.1.5 Executing Any Required Agency Notifications and Permits

Many bridges on the State or U.S. highway system cross facilities require advance notification or permits/coordination with other agencies. Bridges over navigable waterways such as the Mississippi and Missouri rivers will require advance notice to the U.S. Coast Guard so barge operators can be advised of the inspection activities, especially if the inspection will require the mechanical arms of a UBIV to be extended below the superstructure of a bridge where it could conflict with barge traffic. Bridges crossing a border between states will require advance notification/coordination with the adjacent state.

Similarly, bridges over railroads will require notification of the railroads so a UBIV does not conflict with active train traffic. In addition, a railroad flagger will be required to control inspection access windows or train movement during bridge inspection activities. If railroad right-of-way must be crossed or used to provide bridge access, the bridge inspector must have a railroad flagger present, and a right-of-access permit may need to be obtained, depending on the railroad. The railroad must be notified far enough in advance to allow them time to schedule a flagger for the inspection and to obtain the access permit.

If any critical utilities are mounted on the bridge or crossing the bridge that could cause safety concerns (for example, an overhead high voltage line that needs to be de-energized to avoid conflict with the mechanical arm of a UBIV), advance coordination with the utility will be required.

2.1.6 Adjusting Work Schedules

As practicable, but still maintaining NBIS compliance with required inspection frequencies, bridge inspections must be performed when weather conditions will have minimal impact on workflow. If possible, inspections for bridges over rivers and streams might be rescheduled to align with low-flow months to allow the best view and access to components near the waterline. For the most effective inspections, periods of extreme temperature or high winds should be avoided.

The Team Leader must also use their best judgment to determine if inspection activities must be suspended due to changing weather conditions. For example, potential exposure to lightning, particularly when working on steel bridges, would justify suspending inspection operations to ensure crew safety. The safety of the inspectors and the public vehicles traveling through the traffic control patterns should also be considered when inclement weather arises during the inspection period.

2.2 CONDITION EVALUATION OF NATIONAL BRIDGE INVENTORY (SNBI) ITEMS

2.2.1 Appraisal Evaluations

A number of SNBI items for bridges are inspected, evaluated, and coded based on acceptable standards or performance. For example, items B.RH.01 and B.RH.02 for Bridge Railings and Transitions, respectively, are coded based on what standards they were or were not crash-tested to. Deterioration or damage must be noted as part of the inspection report in Item B.C.05 and B.C.06. Other items that require appraisal are Approach Roadway Alignment, Overtopping Likelihood, Scour Vulnerability, Scour Plan of Action, and Seismic Vulnerability.

2.2.1.1 Overtopping Likelihood

Overtopping Likelihood (Item B.AP.02) calls for the inspector’s appraisal of the likelihood that this bridge riding surface is overtopped during times of high channel flow. Bridge overtopping likelihood, since the year built (Item B.W.01), is typically determined from historical bridge inspection or maintenance records, hydraulic studies, local residents/landowners, and/or site indicators including highwater marks on the bridge or its surroundings, debris remains on bridge upper members, etc. For newer bridges with limited historical inspection or maintenance information, hydraulic design information can be used to establish an overtopping likelihood. Therefore, this item appraises the waterway opening with respect to the passage of flow through the bridge. Appraisal ratings consider the roadway's functional classification, the expected frequency of overtopping, and potential traffic delays as a result of overtopping. Table 2.2.1-1 summarizes appropriate appraisal evaluation values for Overtopping Likelihood.

Table 2.2.1-1 Appraisal Values for Overtopping Likelihood

Code	Description
0	Never
1	Remote – once every 100 years or less frequently
2	Very Low – once every 51 to 99 years
3	Low – once every 26 to 50 years
4	Moderate – once every 11 to 25 years
5	High – once every 3 to 10 years
6	Very High – once every 2 years or more frequently

2.2.1.2 Approach Roadway Alignment

Approach Roadway Alignment (B.AP.01) calls for the inspector's appraisal of the approach roadway alignment. This item identifies bridges that do not function adequately due to the horizontal or vertical alignment of the bridge and approach roadway. It is not intended that the alignment be compared to current standards, but rather to the existing roadway alignment. The basic criterion is how the alignment of the bridge and approach roadway relates to the general highway alignment for the section of highway the bridge carries. When reporting this item, do not consider speed reductions due to the bridge width or intersecting highways. The operating speed reduction is in comparison to the posted speed limit for the highway segment. Use code G (Good) when the operating speed is no different at the bridge than the rest of the highway segment that crosses the bridge. Use code F (Fair) when the operating speed is noticeably different at the bridge than the rest of the highway segment that crosses the bridge. Use code P (Poor) when the operating speed is substantially different at the bridge than the rest of the highway segment that crosses the bridge.

2.2.1.3 Roadside Hardware (Bridge Railings and Transitions)

Roadside Hardware Items (B.RH.01 & B.RH.02) call for appraisal of the effectiveness of bridge railings and transitions to redirect errant vehicles and reduce crash severity. The items in this subsection are inventoried to indicate if hardware at the bridge is required, present, or has been crash tested. Do not consider the condition of the hardware when reporting these items. The crash test level to assign to a barrier rail or transition can be found in the Iowa DOT Bridge Rail Guide.

- Bridge Railings (B.RH.01) - This roadside hardware includes all types and shapes of bridge railings (parapets, median barriers, or structure mounted) located on the bridge or that cross over culverts. Use SNBI Table 6 to code this item. If there is more than one type of bridge railing on the bridge, then code the first applicable code working from the bottom of the table to the top.
- Transitions (B.RH.02) – This roadside hardware serves as the transition from the roadside approach railing to the bridge railing and is firmly attached and anchored to the bridge railing to

provide sufficient tension in the transition rail upon impact. Use SNBI Table 6 to code this item. If there is more than one type of bridge railing on the bridge, then code the first applicable code working from the bottom of the table to the top.

- For both above items see SNBI for additional coding guidance for this item with regards to railing specifications and crash testing. Also, refer to State, Federal agency, or Tribal government policies for acceptable bridge railing standards. Use code I when no information is known about the crash test level or an agency-approved standard. Also, use code I when an overlay is applied to the deck/slab and the height no longer meets the original geometry requirements of the crash-tested rail.

2.2.2 General Condition Rating Codes

Condition ratings are used to describe the existing physical state of bridge components as compared to their original as-built conditions. In order to promote uniformity between bridge inspectors, the condition codes used to rate bridge components must characterize the overall condition of the entire component being rated and are not intended to rate localized defects or nominally occurring instances of deterioration or disrepair. A condition rating code must therefore consider the type, location, and severity of the defects; the extent to which they exist throughout the item being evaluated; and the degree to which the defects affect strength and/or performance of the bridge or component.

The as-designed load carrying capacity of the component is not to be used in evaluating condition items. The fact that a bridge was designed for less than the current legal loads, and that the bridge may even be posted, must have no influence on the condition ratings.

The items below as shown in Table 2.2.2-1 are used to describe the general condition ratings of bridges and culverts and are to be updated after each inspection cycle, as is applicable based on structure type, construction and feature crossed. Therefore, the condition of these items provides a simple snapshot of the current overall condition of a bridge or culvert. Note that a condition rating of 5 or less requires a comment on the reasons for this condition rating. See Section 7 of the SNBI for details on how to code these items.

Table 2.2.2-1 SNBI Component Condition Ratings

SNBI Item	Item ID
Deck Condition Rating	B.C.01
Superstructure Condition Rating	B.C.02
Substructure Condition Rating	B.C.03
Culvert Condition Rating	B.C.04
Bridge Railing Condition Rating	B.C.05
Bridge Railing Transitions Condition Rating	B.C.06
Bridge Bearings Condition Rating	B.C.07
Bridge Joints Condition Rating	B.C.08
Channel Condition Rating	B.C.09
Channel Protection Condition Rating	B.C.10
Scour Condition Rating	B.C.11
Bridge Condition Classification	B.C.12
Lowest Condition Rating Code	B.C.13
NSTM Inspection Condition	B.C.14
Underwater Inspection Condition	B.C.15

Descriptive conditions used within the text of an inspection report or descriptive labels used in the comment fields for SIIMS must correlate to the numerical rankings described below and within the SNBI for SNBI Items B.C.01 through B.C.15 based on the deficiencies found for the individual components.

Bridge Condition Classification (B.C.12) is a Good/Fair/Poor coding calculated as shown in Table 2.2.2-2 by FHWA using the lowest condition rating for the deck, superstructure, substructure, and/or culvert items. Note that Item B.C.12 is not intended to be reported by inspectors or designated agency personnel. Lowest Condition Rating Code (B.C.13) is a numerical coding calculated similarly to B.C.12 by FHWA and is not intended to be reported by inspectors or designated agency personnel.

Table 2.2.2-2 Grouping of Descriptive Conditions

Code (B.C.12)	Lowest Condition Rating (B.C.13)	Description
G	7, 8, 9	Component defects are limited to only minor problems.
F	5, 6	Structural capacity of the component is not affected by minor deterioration, section loss, spalling, cracking, or other deficiency.
P	0, 1, 2, 3, 4	Structural capacity of the component is affected or jeopardized by significant deterioration, section loss, spalling, cracking, or other deficiency.

2.2.2.1 Deck, Superstructure, Substructure, Railings, and Bearings

The general condition ratings shown in Table 2.2.2-3 shall be used as a guide in evaluating the Deck (Item B.C.01), Superstructure (Item B.C.02), Substructure (Item B.C.03), Bridge Railing Condition Rating (Item B.C.05), Bridge Railing Transitions Condition Rating (Item B.C.06), and Bridge Bearings Condition Rating (Item B.C.07).

Table 2.2.2-3 General Condition Rating Guidance for Deck, Superstructure, Substructure, Culvert, Bridge Railings, Bridge Railing Transitions, and Bearings (B.C.01-B.C.07)

Code	Condition	Description
N	NOT APPLICABLE	Component does not exist.
9	EXCELLENT	Isolated inherent defects.
8	VERY GOOD	Some inherent defects.
7	GOOD	Some minor defects.
6	SATISFACTORY	Widespread minor or isolated moderate defects.
5	FAIR	Some moderate defects. Strength and performance of the component are not affected.
4	POOR	Widespread moderate or isolated major defects; strength and /or performance of the component is affected.
3	SERIOUS	Major defects. Strength and/or performance is seriously affected. Condition typically necessitates more frequent monitoring, load restrictions, and/or corrective actions.
2	CRITICAL	Major defects. Component is severely compromised. Condition typically necessitates frequent monitoring, significant load restrictions, and/or corrective actions in order to keep the bridge open.
1	IMMINENT FAILURE	Bridge is closed to traffic due to component condition. Repair or rehabilitation may return the bridge to service.
0	FAILED	Bridge is closed due to component condition and is beyond corrective action. Replacement is required to restore service.

2.2.2.2 Culvert (Item B.C.04)

In addition to Table 2.2.2-3 guidance, the additional guidance shown in Table 2.2.2-4 shall be used to evaluate a Culvert (B.C.0.4).

Table 2.2.2-4 Guidance for Condition Ratings for Culverts

Code	Description
N	Not applicable. Used if structure is not a culvert.
9	No deficiencies.
8	No noticeable or noteworthy deficiencies that affect the condition of the culvert. Insignificant scrape marks caused by drift.
7	Shrinkage cracks, light scaling, and insignificant spalling that does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes but without exposure or undermining of footings of wingwalls, curtainwalls, headwalls, or piping. Metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting.
6	Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes with minor exposure of footings but no undermining or displacement. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion, or moderate pitting.

Code	Description
5	Moderate to major deterioration or disintegration, extensive cracking and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion with some undermining of foundations at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, moderate section loss without effect on strength.
4	Large spalls, heavy scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion with moderate undermining of foundations at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection throughout, significant section loss impacting the strength of the culvert.
3	Any condition described in Code 4 but that is excessive in scope. Severe movement or differential settlement of the segments or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe scour or erosion with major undermining at curtain walls, wingwalls, or pipes. Walls exhibit racking and evidence of water infiltration behind walls and under culvert bottom. Metal culverts have extreme distortion and deflection in one section, serious section loss which requires frequent monitoring, load restriction or corrective action.
2	Integral wingwalls collapsed. Severe settlement of roadway due to loss of fill. Section of culvert may have failed and can no longer support embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.
1	Bridge is closed. Corrective action may put it back in light service.
0	Bridge is closed. Replacement is necessary.

2.2.2.3 Bridge Joints Condition Rating (Item B.C.08)

This item addresses the condition of all types and shapes of bridge deck joints. The condition assessment includes all aspects of the joints such as any seals, headers (metal or concrete), connections, and other metal members. When a joint is designed as an open joint, leakage or lack of a seal is not considered a defect. Do not consider the condition of protective coatings and other protection systems when determining the condition rating code for this item, except to the extent that problems with the protective coating system are indicative of problems with the underlying joint material. In cases where the joint is not visible, the inspector can assess the condition based on other indirect indicators of the condition.

Table 2.2.2-5 Bridge Joints Condition Rating (B.C.08)

Code	Condition	Description
N	NOT APPLICABLE	Bridge does not have deck joints.
9	EXCELLENT	Isolated inherent defects.
8	VERY GOOD	Some inherent defects.
7	GOOD	Some minor defects.

Code	Condition	Description
6	SATISFACTORY	Widespread minor or isolated moderate defects.
5	FAIR	Some moderate defects.
4	POOR	Widespread moderate or isolated major defects.
3	SERIOUS	Some major defects.
2	CRITICAL	Widespread major defects.
1	IMMINENT FAILURE	Joints have failed and are ineffective.
0	FAILED	Joints have failed and present a safety hazard.

2.2.2.4 Channel Condition Rating and Channel Protection Condition Rating (Items B.C.09 and B.C.10)

Use the SNBI B.C.09 and B.C.10 tables for coding Channel Condition Rating and Channel Protection Condition Rating, respectively. Table 2.2.2-6 and Table 2.2.2-7 shall be used as additional guidance in evaluating these two related channel items.

Table 2.2.2-6 Channel Condition Rating (B.C.09)

Code	Condition	Description
N	NOT APPLICABLE	Bridge does not cross over water.
9	EXCELLENT	No defects.
8	VERY GOOD	Inherent defects only.
7	GOOD	Some minor defects.
6	SATISFACTORY	Widespread minor or isolated moderate defects.
5	FAIR	Moderate defects. Bridge and approach roadway are not threatened.
4	POOR	Widespread moderate or isolated major defects; bridge and/or approach roadway is threatened.
3	SERIOUS	Major defects. Bridge or approach roadway is seriously threatened. Condition typically necessitates more frequent monitoring, load restrictions, and/or corrective actions.
2	CRITICAL	Major defects. Bridge or approach roadway is severely threatened. Condition typically necessitates frequent monitoring, significant load restrictions, and/or corrective actions in order to keep the bridge open.
1	IMMINENT FAILURE	Bridge is closed to traffic due to channel condition. Channel rehabilitation may return the bridge to service.
0	FAILED	Bridge is closed due to channel condition, and is beyond corrective action. Bridge location or design can no longer accommodate the channel, and bridge replacement is needed to restore service.

Table 2.2.2-7 Channel Protection Condition Rating (B.C.10)

Code	Condition	Description
N	NOT APPLICABLE	Bridge does not cross over water or channel protection devices do not exist.
9	EXCELLENT	Isolated inherent defects.
8	VERY GOOD	Some inherent defects.
7	GOOD	Some minor defects.
6	SATISFACTORY	Widespread minor or isolated moderate defects.
5	FAIR	Some moderate defects. Performance of the channel protection is not affected.
4	POOR	Widespread moderate or isolated major defects; performance of channel protection is affected.
3	SERIOUS	Major defects. Performance of channel protection is seriously affected. Condition typically necessitates more frequent monitoring or corrective actions.
2	CRITICAL	Major defects. Channel protection is severely compromised. Condition typically necessitates more frequent monitoring or corrective actions.
1	IMMINENT FAILURE	Channel protection has failed, but corrective action could restore it to working condition.
0	FAILED	Channel protection is beyond repair and must be replaced.

2.3 EVALUATION USING NATIONAL BRIDGE ELEMENTS

Although component condition rating and reporting, as described in the SNBI, provides a consistent method for inventory, evaluation, and reporting, the data by itself is typically not comprehensive enough to support bridge preservation performance-based decision support. In developing a system for standardized data collection, FHWA decided to look at the structure component condition data where each bridge is divided into only its major parts for condition assessment. A new system was then developed which included a standardized description of bridge elements in a level of greater detail. The AASHTO Guide Manual for Bridge Element Inspection (MBEI) was created to define each element, description, unit of measurement or quantity calculation, set of four standardized condition states, feasibility actions, element commentary, and element definitions. The National Bridge Elements (NBEs) and Bridge Management Elements (MBEs) system provides multiple defects with defined condition states based on severity. This enables deficiencies to be identified within each overall element assessment.

The AASHTO Guide Manual for Bridge Element Inspection, First Edition, 2011, was first published as an official manual in February 2011. The 2011 version was replaced with the AASHTO Manual for Bridge Element Inspection (MBEI), First Edition in 2013. A 2015 Interim for this Manual was released. The document was updated again in 2019 as MBEI, Second Edition, with subsequent 2022 and 2024 interim revisions.

In 2022, the NBIS (23 CFR 650.315) was updated to require that bridge inventory data must include element level bridge inspection data for bridges on the National Highway System (NHS). The NBIS also incorporated the MBEI and SNBI by reference (23 CFR 650.317) and established the AASHTO MBEI as a guide for identifying and quantifying bridge elements for reporting to FHWA. The SNBI is used as a coding guide for inventory and appraisal items. The AASHTO MBEI, Second Edition, 2019 (Section 3) provides a description of structural elements and condition state guidelines including examples that are commonly encountered in highway bridge construction and during bridge safety inspections. National Bridge Elements (NBEs) represent the primary structural components of bridges necessary to determine the overall condition and safety of primary load carrying members. Bridge Management Elements (BMEs) represent secondary bridge components (joints, wearing surfaces, etc.). Element data are only required to be reported to FHWA for bridges that carry NHS routes, while reporting is optional for bridges that do not carry NHS routes. However, Iowa DOT does collect, code, and report data on elements for non-NHS bridges owned by the Iowa DOT.

Condition states describe the severity of the deficiencies in AASHTO bridge elements. All elements have four defined condition states having general descriptions of Good, Fair, Poor, and Severe. Condition State 1 is used to indicate Good condition and Condition State 4 is used for Severe conditions.

National Bridge Elements (NBEs) describe the primary structural elements, including:

- Decks
- Slabs
- Superstructure elements
- Substructure elements
- Culverts
- Bearings
- Railings

Bridge Management Elements (BMEs) are secondary bridge elements that include:

- Deck Joints
- Approach Slabs
- Wearing Surfaces
- Protective Coating Systems

Agency Defined Elements (ADEs)

- Concrete Reinforcing Steel Mixed Protective System (#819)
- Reinforced Concrete Stub Abutment Backwall (#821)
- Reinforced Concrete Wingwall (#825)
- Concrete Culvert Apron (#827)
- Sliding Steel Plate Joint (#831)
- Weathering Steel Protective Coating (#851)
- Concrete Used as a Protective Coating (#855)

2.4 GENERAL INSPECTION PROCEDURES

2.4.1 Deck Inspection

2.4.1.1 Concrete Decks

Concrete decks must be inspected for cracking, spalling, potholes, efflorescence, leaching, delamination, exposed reinforcing steel, and full or partial depth failures. Wide cracks (1/16 inch and wider) in the top and bottom surfaces must be shown on sketches. The path of a crack and its location must be sketched to scale as is practical. Photographs of individual cracks are generally not needed, but if included, they must include a scale or a common item like a pencil for reference.

Spalling, hollow areas, scaling, and patches must be sketched to scale as is practical. Sketches need to be drawn to scale so Bridge Element quantities can be tabulated, checked, and reproduced by another inspector. If an inspector reports a deck is 40 percent hollow, then another inspector must be able to look at the inspector's sketch and calculate a similar quantity of hollow area.

If the concrete deck consists of partial- or full-depth pretensioned panels, it must also be inspected for failures at the pretension and post-tension anchor zones, failures of grout-filled joints between panels, and failures of bearing edges along supporting beams.

Inspection teams must review all existing sketches for accuracy and prepare a cross-section sketch for all bridges. The team's sketch must be an accurate cross-section showing the number of beams (not applicable for slab bridge), left/right sidewalk widths (SNBI Items B.G.07 and B.G.08), curb-to-curb bridge width (SNBI Item B.G.06) and out-out deck width (SNBI Item B.G.05). The bridge rail heights and overlay thickness/material must be recorded, as applicable. The dates of any changes, such as overlays, widening, or retrofit rails must also be recorded.

Curb and barrier rail conditions must be photographed; sketches are generally not needed for curb and barrier rail deterioration. The overall condition of bridge railings must be examined, including the alignment and the height of the rails. Sighting down the line of a bridge rail can be a quick way to identify obvious problems and may also highlight other structural problems, such as substructure settlement. The height of the bridge rail, especially for bridge decks that have been overlaid, must be checked to determine if it meets current design standards. Any damage due to traffic impact must be noted as well as any rotation of the bridge rail. Broken steel or timber railing elements must be noted as well as structural defects that may affect the intended function of the bridge rail, which is to redirect errant vehicles. For precast concrete bridge rails, any apparent anchorage failures or separation from the bridge deck must be noted.

2.4.1.2 Decks with Concrete Overlays

Iowa DOT typically uses two types of overlay material:

- Low Slump concrete (Class O PCC)
- High Performance Concrete (Class HPC-O PCC)

As shown in Table 2.4.1-1, the estimated bridge quantities will include both Low Slump concrete (Class O PCC) and High Performance Concrete (Class HPC-O PCC) as alternatives on the construction plans, so it may be necessary to ask the Iowa DOT construction office which alternative was used. As-built plans must indicate which alternative was installed, as well.

Table 2.4.1-1 Sample Estimated Bridge Quantity Table

ESTIMATED BRIDGE QUANTITIES			SEE SHEET 14 FOR ADDITIONAL BID ITEMS RELATING TO ROADWAY REPAIRS		
ITEM NO.	ITEM CODE	ITEM	UNIT	TOTALS	AS-BUILT QUANTITIES
1	2401-6750001	REMVL (REMOVALS, AS PER PLAN)	LS	1	1
2	2402-2720000	EXCAVATION, CL 20	CY	14.0	14
3	2403-0100000	STRUCT CONC (MISC)	CY	29.3	29.3
4	2404-7775005	REINFORC STEEL, EPOXY COATED	LB	3418	3418
5	2413-0698072	BRIDGE FLOOR REPAIR, CL A	SY	102	98.075
6	2426-6772016	CONC REPAIR	SF	80	114.299
7	2528-8400048	TEMPORARY BARRIER RAIL, CONCRETE	LF	1350	1350
8	2533-4980005	MOBILIZATION	LS	1	1
		ALTERNATE A			
9A	2413-0698068	BRIDGE FLOOR OVERLAY (CL O PCC)	SY	513.8	
		ALTERNATE B			
9B	2413-0698068	BRIDGE FLOOR OVERLAY (CL HPC-O PCC)	SY	513.8	513.8

Other types of overlays / wearing surfaces Iowa uses that would be coded in Item B.SP.10 include:

- C01 - Monolithic
- C03- Latex modified
- C04- Low Slump (PCC-O)
- C05 - Fiber Reinforced (UHPC)
- CX - Other (HPC-O)
- P01 - Polymer - Epoxy
- P02 - Polyester - Polymer (PPC)

2.4.1.3 Sounding Concrete Decks

A sounding is performed by use of one of several methods. Chain drag, hammer tapping, or steel rod/pipe tapping are the three typical methods used to sound a bare deck for delaminations (hollow areas). These methods can be used separately or together to gather the data needed to estimate the area of the deck that is delaminated. When using a hammer or steel rod/pipe, taps must be approximately 2 feet apart and must cover the entire area of the deck. The chain drag will generally be used in a sweeping motion with passes that are approximately 2 feet apart and cover the entire deck area.

Areas around deck cracks 1/16 inch or wider must be given closer attention due to the higher probability of a delaminated area developing. Discolored areas of the deck must also be sounded more rigorously.

When a delaminated area is found, the extent of the delamination must be documented on a sketch. The total area of delamination on a deck must be calculated and included in the inspection notes.

2.4.1.3.1 Sounding Concrete Decks with Concrete Overlays

The following criteria shall be used to determine whether a concrete bridge deck with a concrete overlay requires sounding:

1. A deck with a new overlay does not require sounding until the overlay is 10 years old unless extensive cracking or significant spalling has occurred.

2. The frequency of sounding, after the initial sounding, will be based on the findings of the initial sounding. Bridges and Structures Bureau (BSB) engineering staff will determine the recommended frequency.
3. A deck that has been epoxy injected or had patching by contract shall be sounded on the third inspection after this work was completed. The frequency of future soundings will be determined by BSB engineering staff.
4. No future soundings are required if a deck has become hollow over 40 percent of its deck area.

Spalling, scaling, and patching of the overlay must be documented with sketches and photographs at all inspections. Photographs of typical or the most severe deterioration are recommended. Epoxy-injected areas must be labeled with the year of injection on the sketches.

2.4.1.3.2 Sounding Concrete Decks and Integral Superstructure Riding Surfaces without Overlays

Concrete decks and integral superstructure ridings surfaces without an overlay shall initially be sounded when the deck is 20 years old. A sounding may be required sooner if evidence of extensive cracking is found, or spalling is occurring. After the initial sounding, BSB engineering staff will determine the frequency of future soundings. Spalling, scaling, and patching must be documented at all inspections with sketches. Photographs of typical or the most severe deterioration are recommended.

2.4.1.4 Steel Decks

Steel grid decks must be inspected for corrosion, broken welds, broken or damaged bearing bars or cross bars, and section loss. Concrete-filled steel grid decks must be checked for spalling or scaling of the concrete infill, water ponding, corrosion of steel grid members, and leakage on the underside of the deck. Corrugated metal decks must be checked for evidence of rust-through and open cracks in the wearing surface. Orthotropic steel decks also need to be checked for evidence of rust-through; cracks in the steel plate, web elements, or welded connections; and debonding of the overlay.

2.4.1.5 Timber Decks

Timber decks must be inspected for splits, checks, shakes, broken planks, crushing, excessive wear, rot, and loose, broken, or missing fasteners. Areas exposed to traffic must be examined for weathering, wear, and impact damage. Drainage deficiencies can manifest themselves as rot or stained lumber on the top or bottom of the deck or on the outside edges of the deck. Laminated timber decks must be checked for loose or delaminating members, and if the laminated members are post-tensioned together, post-tensioning anchorages must be checked for corrosion, crushing, decay, or signs of anchor failure.

2.4.1.6 Bridge Joints

Iowa DOT bridge inspections document the following two types of joints:

- Deck joints
- Pavement pressure relief joints

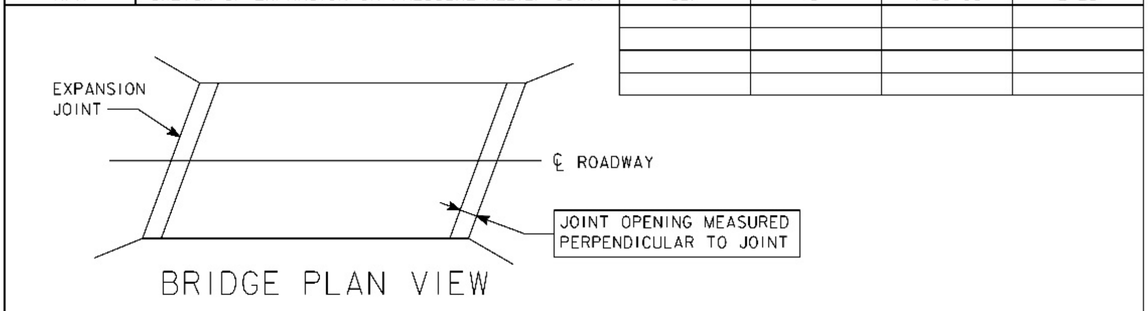
2.4.1.6.1 Deck Joints

Deck joints are designed to accommodate deck and superstructure expansion and contraction caused by temperature changes. The inspection must confirm the joints are functioning properly and must document any deterioration to the joints.

A BME for the joint type must be used to report the condition of the joints. The descriptions of the BMEs for joints and their condition states can be found in the latest AASHTO MBEI Manual, including addendums.

Proper function is reported by preparing a bridge plan view sketch along with a table to summarize the joint opening. The joint opening is the distance available for bridge movement, and this value should change with temperature changes. The sketch and table of the joint opening must be similar to Figure 2.4.1-1.

SCALE	BRIDGE NO.	SKETCH BY	TEMPERATURE	DATE	PAGE
N/A	SKETCH OF EXPANSION OR PRESSURE-RELIEF JOINT	GLP	75°	7-20-09	B-25



LOCATION	JOINT OPENING AT: LEFT GUTTER	CENTERLINE	RIGHT GUTTER	JOINT TYPE	REMARKS
115' BACK ON NEAR APPROACH	-	2"	-	POLY RELIEF	SEALED
NEAR ABUTMENT	1¼"	¾"	½"	SLIDING STEEL PLATE	DEBRIS FILLED
FAR ABUTMENT	½"	¾"	¾"	SLIDING STEEL PLATE	DEBRIS FILLED
120' AHEAD ON FAR APPROACH	-	2"	-	POLY RELIEF	SEALED

Figure 2.4.1-1 Joint Opening Sketch

The air temperature must be documented, and the joint opening must be measured in three locations (2 feet from the left and right gutterlines and at the bridge centerline).

Sliding steel deck joints can be difficult to measure if the deck has been overlaid. Figure 2.4.1-2 shows a common sliding steel deck joint modification from an overlay project.

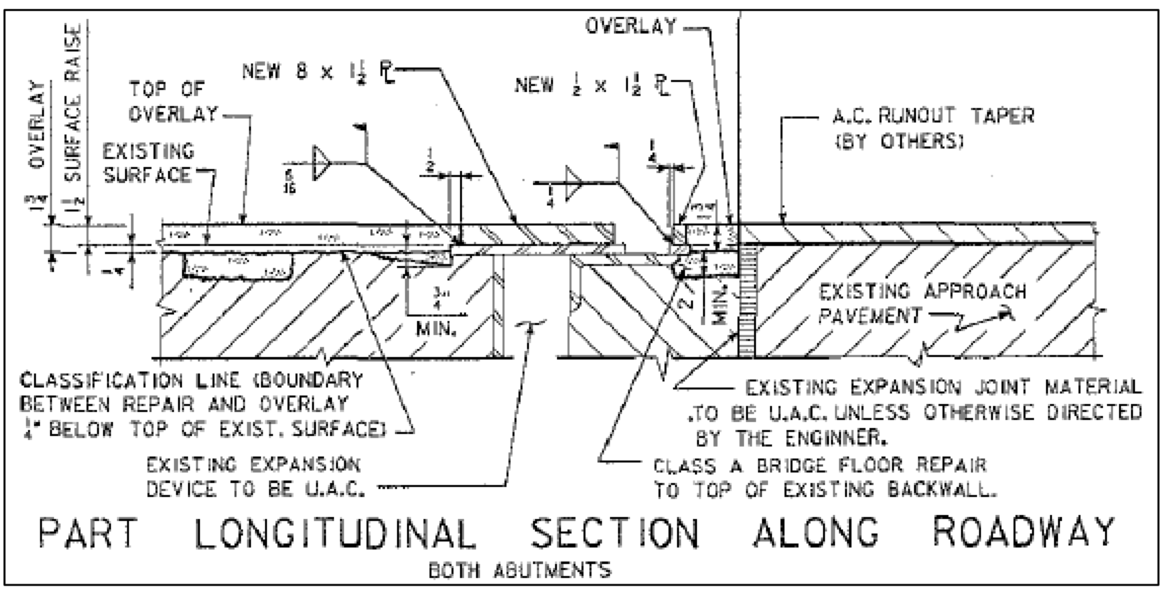


Figure 2.4.1-2 Sliding Steel Joint Retrofit

The new wear plates and stop bars are often physically smaller than the originals to allow space for the contractor to weld them in place. If the original design opening in the above example was 2 inches at 50 degrees Fahrenheit, the opening in the example above will appear to be 2¾ inches after placement of the overlay.

Unlike the detail above, actual joints will be filled with sand, gravel, salt, and vegetation which will make measuring the opening between the original wear plate and stop bar difficult, if not impossible. The inspector must compare field observations of the new wear plates and stop bars to the overlay plans to calculate the joint opening. A whisk broom can be used to spot clean joint locations requiring measurements.

Sliding steel plate joints are not intended to be water-tight and normally leak. They are undesirable for all bridge types, especially pretensioned/prestressed concrete beam (PPCB) superstructures. Iowa DOT no longer permits sliding steel joints on PPCB bridges and is actively working to retrofit existing installations. Sliding steel plate joints are commonly damaged by snowplows, especially those joints modified during an overlay project. Indications of damage include joint deflection and banging at the joints when vehicles pass. These may indicate loose anchorages or broken welds. The District Bridge Repair Crew Leader must be notified if sliding steel joints are found to have loose wear plates or stop bars that could break loose and protrude into traffic.

2.4.1.6.2 Pavement Pressure Relief Joints

Pavement Pressure Relief Joints (PPRJ) are designed to accommodate the expansion of concrete pavement. These joints are desirable in concrete pavements approaching a bridge to prevent the expanding pavement from "pushing" on the bridge. In general, if a PPRJ has a joint opening wider than 2 inches, it will provide adequate movement for the pavement. Inspection must confirm the joint opening is wider than 2 inches and must document deterioration.

There is not a BME for PPRJs, so proper joint opening and deterioration must be reported by preparing a sketch similar to the example shown in Figure 2.4.1-1.

As for the deck joints, the air temperature must be documented, and the joint opening must be measured at the bridge centerline and 2 feet from the gutterlines.

If an inspector finds a PPRJ with an opening less than 2 inches, a recommendation to re-cut the PPRJ may be necessary. Before making this recommendation, the following must be considered:

1. Is the joint an EF joint?
2. Does the bridge have integral abutments with visible deck joints?

EF joints are a specific type of PPRJ. They are constructed with dowels spanning between two slabs. EF joints are marked with an "X" in the pavement next to the joint, as shown in Figure 2.4.1-3.

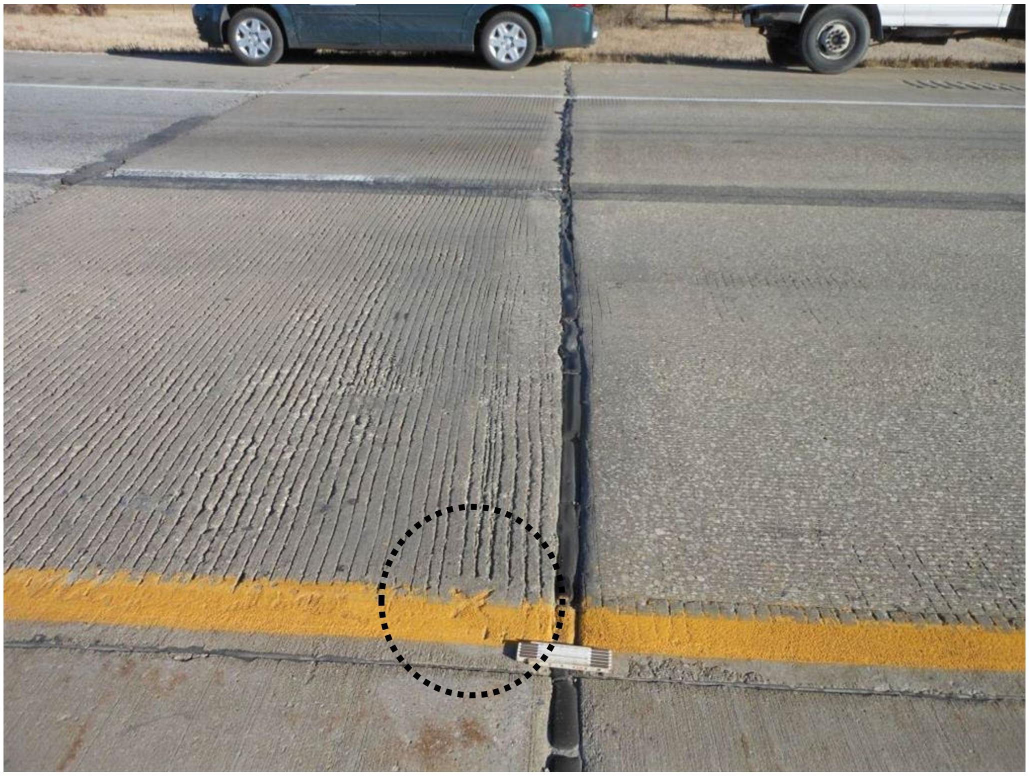


Figure 2.4.1-3 EF Joint Pavement Marking

An EF joint does not necessarily require replacement when the opening is less than 2 inches. An EF joint cannot simply be re-cut; sections of pavement must be removed to make room for replacement slabs, so inspectors must not recommend re-cutting an EF joint. If the joint opening is less than 2 inches, inspectors must look for damage to the pavement at the EF joint before recommending replacement.

Bridges with integral abutments are built with expansion joints between the deck and the approach pavement. If the deck joint opening and the PPRJ opening measure 2 inches or more when combined, then the approach pavement has adequate room for expansion. No recommendation is needed to re-cut the PPRJ in this situation. However, if the deck joint at an integral abutment has been filled with hot-mix asphalt (HMA) during an HMA overlay of the approach, then the joint is no longer considered an expansion joint, and the PPRJ alone must measure 2 inches or more to have adequate room for expansion.

PPRJs are generally located 60 to 75 feet from the ends of a deck. If there is not a PPRJ within 100 feet of the end of a deck and evidence of a PPRJ is not visible when standing 100 feet from the end of a deck, a recommendation to re-cut the PPRJ may be necessary.

When PPRJs are visible, their distance from the deck must be recorded because it is common for PPRJs to be covered when a roadway is overlaid with an asphalt leveling course. If a PPRJ is covered with HMA and is no longer visible, the joint is still considered adequate if the joint opening was previously wider than 2 inches. Inspectors must report when the joint was covered in the joint sketch and must monitor the location for raveling asphalt.

A PPRJ that does not extend through the shoulder is considered adequate. This situation must be noted in the joint sketch, but it is not a condition that needs to be addressed.

2.4.1.7 Coding SNBI Item B.C.01 (Deck Condition Rating)

The overall condition of a bridge deck must be coded as shown in Table 2.2.2-2 Grouping of Descriptive Conditions for Item B.C.01 (Deck). For culverts or other structures without a deck, such as a corrugated metal structural plate arch bridge, code N (not applicable) must be used for Item B.C.01.

Decks integral with the superstructure, such as slabs, cast-in-place box girder bridge or a concrete T-beam bridge, shall be rated for the deck only, and the superstructure condition of the integral deck-type bridge must not influence the deck rating. When the deck component condition rating is 4 or less, the superstructure component condition rating may be reduced if the recorded deck defects reduce the bridge's ability to carry applied stresses associated with superstructure moments.

The condition of supplemental wearing surfaces, joints or expansion devices, curbs, sidewalks, parapets, railings, and drainage scuppers must not be considered in the overall deck evaluation. However, their condition must be noted in the inspection report.

A condition rating of 5 or less requires a comment on the reasons for this condition rating.

2.4.1.8 National Bridge Elements

The descriptions of the NBEs for decks and their condition states can be found in the latest AASHTO MBEI Manual, including addendums.

1. When an element has defects in Condition States 3 or 4, the reviewers in the office will want to know more about the defect than just the square footage or quantity.
    a. Reports must include photographs and/or sketches that convey the extent and location of defects that are in Condition States 3 or 4.
    b. If a defect cannot be completely described with a sketch and/or photo, additional description must be included in the Reviewer's Comments field such as "Deck deflection in bay 1 was noted under live load."
    c. Short descriptive locations of CS3 & CS4 defects in the Reviewer's Comments field may be helpful, such as "Exposed rebar has up to 1/8" deep section loss."

2.4.1.9 Additional SIIMS Deck Data

The Deck section in SIIMS has several items that are not part of the SNBI or NBE data. These items must be verified and updated at each Routine or In-Depth Inspection.

2.4.1.9.1 Deck Drains

The deck drain type is to be chosen from the drop-down menu in SIIMS. The drop-down options include the following:

- Unextended
- Empties into Pipe
- Steel Extension
- Plastic Extension
- Miscellaneous
- None

The condition of the deck drain must be determined as Good, Fair, or Poor. If no drain extension exists, N/A must be selected from the condition drop-down menu. If a drain is in Poor condition, a comment must be included describing why it is considered to be in Poor condition.

2.4.1.9.2 Curb Type – Left and Right

The type of curb on the bridge deck for the left and right curbs must be chosen from the drop-down menu in SIIMS. The drop-down options include the following:

- < 9”
- ≥ 9”
- Sidewalk
- Sidewalk with Traffic Division
- Curb with Retrofit Rail
- Miscellaneous
- None

The condition of the curb must be determined as Good, Fair, or Poor. If the curb type is “None,” N/A must be selected from the condition drop-down menu. If a curb is in Poor condition, a comment must be included describing why it is considered to be in Poor condition. See section 4.3.1.4 for instructions regarding coding left and right sidewalk widths per SNBI.

2.4.1.9.3 Cantilevered Curb

A cantilevered curb refers to a curb that overhangs the edge of the deck. The concern with this type of curb is corrosion of the tension reinforcing along the gutter line. Figure 2.4.1-4 and Figure 2.4.1-5 show sample sketches of non-cantilevered and cantilevered curbs. A barrier rail on a thin concrete deck that is supported by steel channels or steel cantilevers is not considered a cantilevered curb.

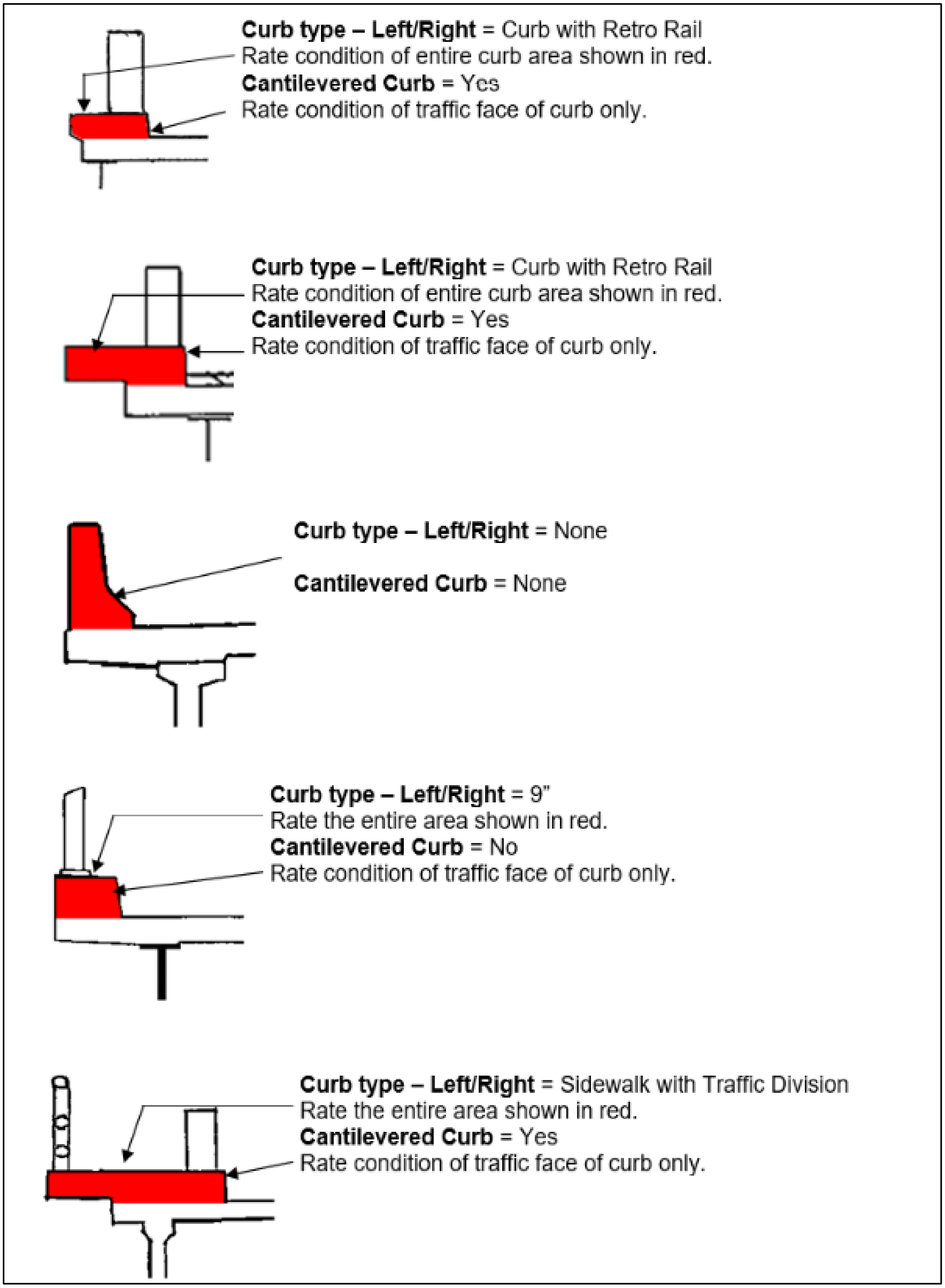


Figure 2.4.1-4 Non-Cantilevered and Cantilevered Curbs (1 of 2)

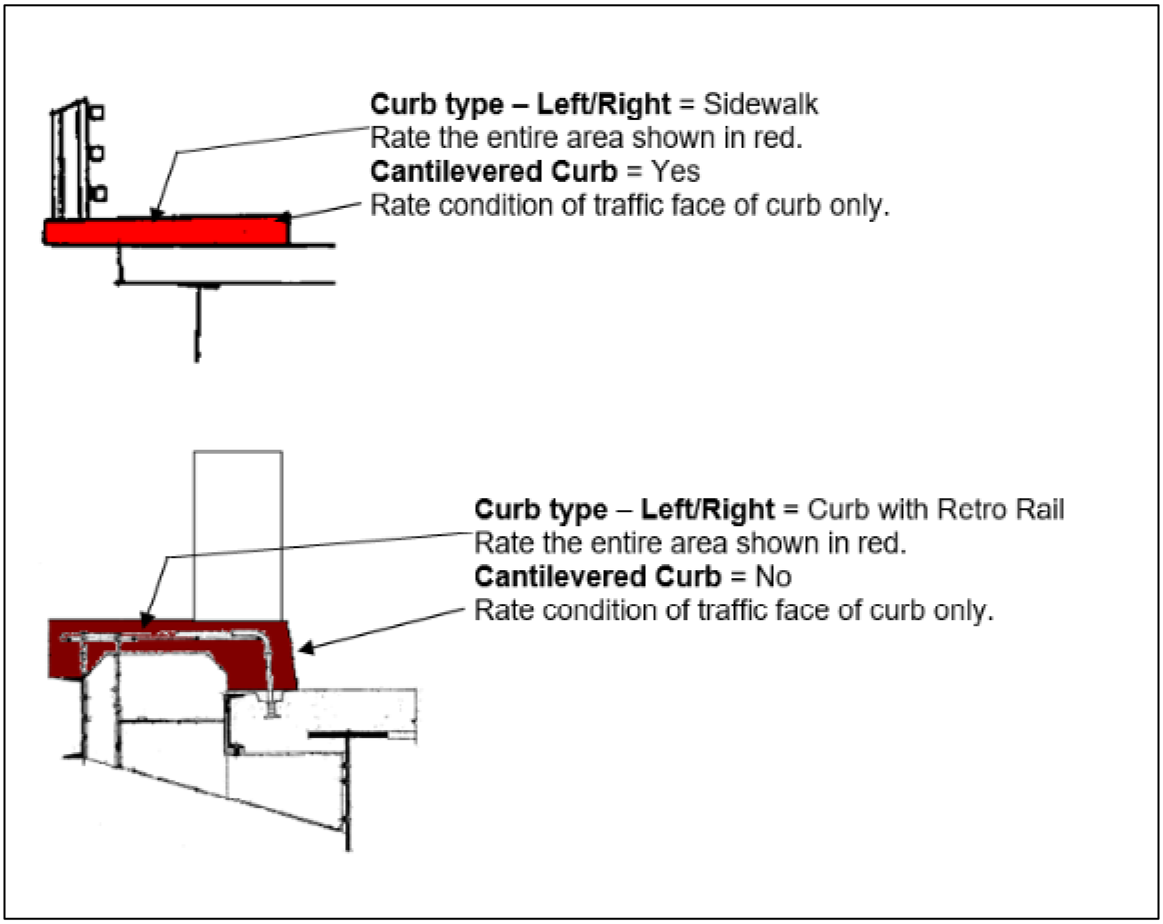


Figure 2.4.1-5 Non-Cantilevered and Cantilevered Curbs (2 of 2)

2.4.1.9.4 Bottom of Deck Delamination over Traffic

Delamination is defined as concrete that sounds hollow and typically shows a visible crack that is partially or completely around the perimeter of the hollow area. Delaminations on the bottom of a deck over traffic lanes of a highway, a railroad, a parking area, a sidewalk, or a recreational trail have the potential of falling onto vehicles or pedestrians below and must be removed according to Maintenance Instructional Memorandum 6.102.

The District must be notified of the delaminated areas. At a minimum, e-mail the District Bridge Crew Leader, District Operations Manager, District Maintenance Manager, and an BSB contact person a message that includes the following information:

1. Bridge ID (Maintenance number) and FHWA number
2. Bridge location and span(s) where delaminations were found
3. Sketch of delamination locations
4. A request for e-mail notification to BSB when the delaminations have been removed
5. E-mail address and phone number of BSB contact

“Yes” is to be selected from the drop-down menu in SIIMS when delaminations are found. Once “Yes” has been selected, this must never be changed to “No” unless the deck is replaced. When this item is “Yes,” a note must be made in the comment field after each inspection, saying whether more delaminated concrete was found.

2.4.1.9.5 *Left and Right Bridge Rail*

The left and right bridge rail type is included in the SIIMS data for a national research project. These items must be updated when the barrier rail type changes. The types available in the drop-down menu are:

1. Metal Tube Bridge Rail
2. Open Concrete Rail
3. Vertical Parapet
4. Safety Shape Concrete Barrier (F-shape/Jersey)
5. Timber Bridge Rail
6. Thrie Beam Bridge Rail
7. W-Beam Bridge Rail
8. Constant Slope Concrete Parapet

2.4.1.9.6 *Left and Right Guardrail*

The type of existing guardrail installations must be verified each inspection.

The inspection team must complete the guardrail descriptions. The August 2010 Guardrail Identification Manual must be used to identify the end, rail, and transition types.

2.4.1.9.7 *Approach Pavement*

The five types of approach surfacing documented in SIIMS are as follows:

1. Concrete w/HMA Overlay – Full-depth concrete, with an HMA overlay
2. Concrete – Full-depth concrete, without an HMA overlay
3. Other – Wood, masonry, or experimental surfacing other than concrete, asphalt, or gravel
4. Asphalt – Full-depth HMA with no concrete substrate
5. Gravel – Full-depth granular material

In SIIMS, the inspector must select one of these five categories for the near and far approaches. A comment describing the condition of the approach and ride quality must be included. If the pavement beyond a concrete approach is HMA, include a comment that no pressure relief joint is needed.

Look for voids at approaches that may be caused by erosion or settlement. A small void behind an integral abutment is normal due to movement of the footing from thermal expansion and contraction. Voids under approach slabs are not included within the defects for NBEs 320 and 321 Prestressed / Reinforced Concrete Approach Slab, so they must be documented in the comment boxes for the Near and Far approach sections on the Deck tab in SIIMS. Voids under Asphalt and Other approaches and wash outs on Gravel approaches must be documented in the comment boxes on the Deck tab. The inspection team must notify the BSB before leaving the site if the voids extend into the travel lanes.

2.4.2 Superstructure Inspection

Superstructure members must be inspected for signs of distress, which may include horizontal or vertical displacement of components affecting structural stability, cracking, deterioration, section loss, collision damage, or overload damage.

A discussion of how member components must be numbered and identified for the inspection report is provided in Section 1.6.2 of this manual.

2.4.2.1 Concrete Slab

A concrete slab bridge does not contain beams or girders. The deck and superstructure are synonymous and must have the same GCR. Concrete slab bridges contain larger reinforcing bars than a standard deck. Continuous slabs have large reinforcing bars over the piers near the top of the deck. Transverse cracking over a pier must be documented because of the increased potential for corrosion of the main reinforcing steel in this area.

Concrete deterioration near the abutments must be documented whether it is occurring on the top or bottom of the slab. Severe deterioration in this area can affect the shear capacity of the concrete slab. Repairs to this area due to deterioration are difficult. Temporary support of the deck may be required in some cases.

Photographs and sketches of deterioration in high stress areas are required.

2.4.2.2 Reinforced Concrete Beams and Tee Beams

A reinforced concrete beam bridge is a cast-in-place concrete structure. When the beams are placed monolithically with the deck, as in most cases, they are called tee beams. The deck, acting as a top flange, is likely to contain more reinforcing than a conventional deck on a girder bridge. Deterioration of the deck can have a greater impact on the load capacity of this type of bridge than a typical girder bridge.

Cracking of the deck or girders in high stress areas shall be documented with sketches. Signs of rust staining must also be included in the inspection documentation with photographs and written descriptions.

Girder deterioration shall be sketched and photographed at bearing areas.

2.4.2.3 Prestressed Concrete Beams

Prestressed concrete beam bridges are typically I-beam, bulb tee beam, channel beam, double tee beam, or box beam structures. In all of these types of bridges, stressed strands or bars induce compressive forces into the concrete to give the beam the required load carrying capacity. This load carrying capacity can be compromised by concrete deterioration around these strands or bars. The most common reason for loss of prestress capacity is due to deterioration and spalling at the ends of the beams where salt-laden water can leak onto the beam ends through open or leaking deck joints and contaminate the concrete, thus causing corrosion to begin in the strand or bar. Prestressed steel is more susceptible to corrosion and will corrode faster than mild steel reinforcing.

The second most common reason for loss of prestress capacity is due to impact loads by over-height vehicles. Impacts can cause spalling and delamination around the strand or bars, so the compressive force applied to the concrete is lost due to debonding of the strands with the spalled or delaminated concrete in the impacted area. Spalling and delamination will lead to a loss of prestress capacity, in addition to corrosion. If a wire, strand, or bar is severed because of impact, this also causes a loss in prestress force.

Cracking in the high stress areas of prestressed beams shall be documented with sketches in the inspection report. The number and location of strands or bars exposed due to deterioration or impact damage are to be included in the inspection report. Photographs of deterioration or damage are required.

Prestressed girder bridges with five or more spans over a waterway (or otherwise inaccessible due to height, traffic and/or terrain) must be inspected with an Underbridge Inspection Vehicle (UBIV) on a minimum six-year cycle. Beam ends and pier caps cannot be adequately inspected from the ground when they are located over a large body of water. If cracks of significant width and size are found in the end span girders near the abutments during a ground-level inspection, consideration must be made for using appropriate access equipment at the next inspection to determine if similar cracks are occurring in other girders ends not otherwise accessible. Please note that CS2 cracking is not serious enough to warrant access equipment and traffic control on high traffic volume highways.

2.4.2.4 Steel Beams and Girders

Steel beam or girder bridges are made up of two or more beam lines of I-shaped members. Inspection of steel superstructure elements must include checking steel members for corrosion, section loss, evidence of fatigue or fracture, evidence of overload, collision damage, connection damage, and possible damage from excessive heat. Deterioration must be documented in the superstructure NBEs. Inspection procedures typically include visual methods to find defects as well as physical methods such as hammer sounding, cleaning to remove rust scale, and measuring remaining steel thickness. Visual and physical inspection procedures must focus on high stress zones, areas exposed to drainage run-off, areas exposed to traffic, previous repair locations, previously noted defects, and fatigue-prone or fracture-prone details.

Inspection of steel superstructure elements must further include an assessment of protective coatings and all deterioration must be documented in the protective coating BMEs. These protective coatings could include a primer/paint system, galvanizing, or in the case of weathering steel members, the coating is an oxide layer or patina allowed to form on the steel surface. Properly applied paint coatings must be free of chalking, pitting, rust, flaking, or generalized rust staining.

For weathering steel members, the oxide colors expected for properly developing patinas include a yellow-orange color for new steel or a purple-brown color for members in service for many years. Weathering steel members exhibiting a black or yellow color could indicate a failed condition of the protective oxide and may show small flakes (approximately ¼ inch in diameter) or laminar sheets of loose oxide film. The overall condition of the weathering steel is to be rated according to the visual patina rating shown in Figure 2.4.2-1 and Figure 2.4.2-2. Periodically the visual patina rating must be verified with a tape test. Periodic patina testing must be at least every six years.

When coding MBE Element 515 “Steel Protective Coating” or ADE Element 851 “Weathering Steel,” both for weathering steel, the following should be used:

Patina Rating (PR) of

- PR7 & PR8 = CS1
- PR6 = CS2
- PR5 = CS2 to CS3
- PR4 = CS3
- PR3 = CS4

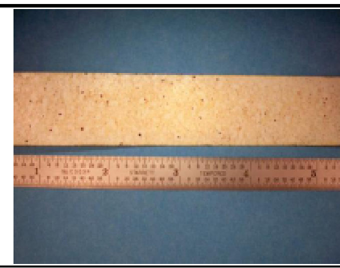
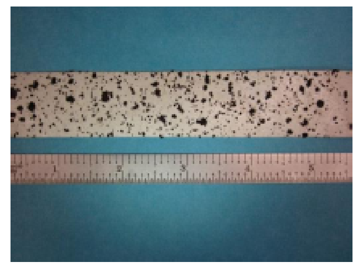
Patina Rating	Condition Description	Example Condition in Field	Example Tape Test Specimen
8 Very Good	Uniform color pattern, generally dark brown with some lighter reddish-brown, metallic and purple-brown spots. May be difficult to see small rust product clusters. Texture may be dimpled or rough but uniform in pattern. Patina layer is thin but dense and very adherent, indicative of very good protective properties. Superior adherence; tape test sparse with only very small flakes (< 1 mm).		
7 Good	Uniform color pattern, generally dark brown with some lighter reddish-brown, metallic and purple-brown spots. Individual rust product clusters visible. Texture is dimpled or rough but uniform in pattern. Patina layer is thin but dense and adherent, indicative of good protective properties. Tape test easily removes very small (< 1 mm) flakes.		
6 Satisfactory	Dark brown coloration, but begins to show minor variation. 1-5 mm flakes loose on surface, easily removed with tape test. Underlying layer adherent, still relatively dense, thin and protective. Texture more granular and loose flakes may be less-protective, holding water and salts. Chalky poultice layer may be present, but not significantly affecting performance (i.e., flake size).		

Figure 2.4.2-1 Weathering Steel Patina Rating (1 of 2)

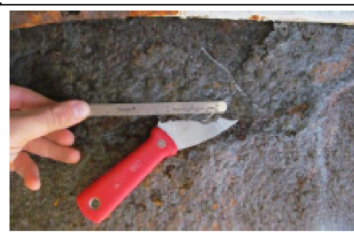
Patina Rating	Condition Description	Example Condition in Field	Example Tape Test Specimen
5 Fair	Dark brown with black and some color variation. Blotchy with some salty or rusty stains. Medium (5-25 mm) flakes over most of area loose and non-protective, easily removed with tape test. Layer beneath flakes thicker and more permeable, with some pitting beginning. Non-protective; contaminants penetrating. Elements with poultice may show significant associated flaking.		
4 Poor	Color is dark brown and black but non-uniform, with widespread blotchiness and staining. Non-protective. Large (> 25 mm) flakes, or layered delamination beginning in some areas. Thickness/permeability of rust increased, with pitting and section loss possible. Poultice areas have thin delamination sheets or very large flakes. Layer below loose poultice may appear similar, but still somewhat adherent.		
3 Serious	Blackish, stained, blotchy appearance. Formation of laminar sheets with deeply pitted semi-adherent layer beneath; chunks and sheets of rust product removable by hand. Aggressive advancement of pitting and section loss; can be up to 50%. Complete failure of patina to protect base steel.		

Figure 2.4.2-2 Weathering Steel Patina Rating (2 of 2)

A tape test is a physical assessment of the patina. A strip of tape 8 to 12 inches long is pressed firmly onto the patina surface. After waiting for a period of at least one minute, the tape is peeled off of the surface quickly and smoothly at a steep angle between 90 deg. and 150 deg. from the patina surface. The tape will remove samples of the oxide layer that must be compared to the rust flake size and spatial distribution shown in Figure 2.4.2-1 and Figure 2.4.2-2.

The tape must be a white cross-hatch tape which conforms to all ASTM D3359 standards and can be used for both ASTM D3359 Method A (X cut) tape test method or ASTM D3359 Method B (cross hatch) tape test method or as provided by the BSB. Remove two wraps of tape before cutting the 8 to 12 inch strip used for the test. Photographs of the tape tests must be included in inspection reports. Label each tape test photograph with the sample location and patina rating assigned to the sample. The sample locations selected must be representative of the majority of the surface condition.

Weathering steel girders over paved roadways or within 30 ft. of an adjacent bridge deck must be periodically tape tested to document the influence of moisture and deicing chemicals on the oxide layer. The sample locations do not need to be over traffic, samples over the shoulder will provide sufficient splash zone exposure to document changes over time.

Steel girder bridges, either painted or weathering steel, with spans over a waterway (or otherwise inaccessible due to height, traffic, or terrain), shall be inspected with an UBIV on a minimum six-year cycle, since beam ends and pier caps cannot be adequately inspected from the ground when they are located over a large body of water. These superstructures are typically at a significant height. This six-year UBIV cycle is implemented to limit the amount of traffic control required on high volume highways, especially interstates.

Boats are used when there are piers in the water. Girder potential issues seen from the water will be identified for close up inspection as needed at a Special inspection or the next Routine inspection. Note that steel bridges with triaxial constraint issues have all been retrofit in Iowa.

Bolted or riveted connections must be inspected for loose or missing bolts or rivets, section loss to the bolt or rivet heads, and corrosion of the connecting parts. Pack rust can build up between the connection plate and the girder element, which can cause bending in the connection plate and unanticipated tensile stress in the bolts or rivets.

Instances of overload to a steel structure will usually be manifested in high stress zones. Therefore, if overload is suspected, particular attention must be paid to bearing areas where the load would be transferred from superstructure to substructure; high shear zones adjacent to member supports and points of concentrated loads; and elevated stress levels in high moment regions, including the middle third of a span for positive moment and the end fourths at intermediate supports for negative moment in continuous spans.

Areas of collision damage must be carefully inspected for signs of fracture or member cracking; distortion due to collision must be documented and quantified in the inspection report. If cracks or gouges in the steel members have occurred due to collision damage, dye penetrant or magnetic particle testing may be required to accurately determine the extent of the defect.

2.4.2.4.1 Fatigue-Prone Details and SNBI Item B.IR.02 Coding

Fatigue-prone details include, but are not limited to, the following:

- Welded cover plates, particularly the end terminations
- Web gap area at diaphragm stiffeners when out-of-plane bending is possible
- Welded gusset plate connections to girder webs, flanges, or truss members
- Weld terminations of longitudinal stiffeners
- Coped areas in a floorbeam or cross beam
- Tack welds in tension areas
- Intersecting welds

Fatigue is the tendency of a member to fail at a stress level below yield stress when subjected to cyclical loadings. Fatigue-prone details require additional attention. If fatigue cracks or fractures are noted, non-destructive testing methods, such as dye penetrant testing or magnetic particle testing, may be required to determine the extent of cracks in steel members. Ultrasonic methods are typically used to test pin members for defects.

Triaxial constraint is a 3-dimensional stress state that reduces the ductility of a material. Under triaxial constraint, steel is unable to deform, and brittle fracture can occur under service conditions where ductile behavior is normally expected. Due to the nature of these unique conditions, the chance for member failure is greater for these conditions and they warrant added emphasis during inspection. Finally, the ability of inspectors to recognize conditions of triaxial constraint is important to guard against brittle failure.

AASHTO prioritizes fatigue details into categories from A (least critical) to E’ (most critical). The inspector shall be familiar with the various fatigue categories and be able to classify the categories encountered in the field to determine the seriousness of the detail. Fatigue-prone details must be identified and noted in the inspection report so that details can be monitored for cracks in subsequent inspections.

SNBI Item B.IR.02 must be coded N or Y, depending on whether it has any E or E’ fatigue prone details.

2.4.2.4.2 Non Redundant Steel Tension Members (NSTMs)

NSTMs are steel members in tension or with a tension element, whose failure would be expected to cause a partial or full collapse of the bridge. The NBIS requires NSTMs to be inspected at “arm’s length.”

Floorbeams are primary superstructure members that transmit loads from the deck to the main girders or trusses. Floorbeams are generally considerably shorter than girders and are oriented perpendicular to traffic. They may be in direct contact with the bottom of the deck, or they may support longitudinal stringers, parallel to the main girders or truss. Stringers may be continuous or simply supported at the floorbeams. Steel floorbeams are considered NSTMs when any of the below conditions exist:

1. The connections to main girders are considered flexible or hinged.
2. There are no stringers.
3. The stringers are configured as simple spans.
4. The stringers are continuous and the floorbeam spacing is greater than 14 feet.

Other NSTM members on various types of bridges are discussed in sections below.

2.4.2.4.2.1 NSTM PRE-INSPECTION PREPARATION

Prior to inspecting a bridge with known NSTMs the following procedures must be used in preparation for the inspection:

1. Review the NSTM locations as identified in the bridge file.
2. Identify all fatigue-prone details requiring a hands-on inspection.
3. Determine what documentation will be needed as part of this inspection.
4. Determine the workflow needed and access requirements for inspecting the NSTMs in the most efficient manner.
5. Discuss the workflow with all the members of the inspection team so they understand their role in the inspection. It is recommended the workflow be documented and kept in the bridge file.
6. Assess the equipment needs to perform this inspection. This will include lighting adequate to identify small defects. Keeping a list of the equipment needed for the inspection in the bridge file is recommended.
7. Make arrangements to have the superstructure washed if debris, bird nests, or bird droppings inhibit proper inspection of important areas.
8. Make arrangements to have the necessary access equipment available for the inspection.
9. Verify who must be notified if a potentially serious condition is found.

2.4.2.4.2.2 REQUIREMENTS DURING NSTM INSPECTION

During an NSTM inspection, the following procedures must be used:

1. Perform a hands-on inspection to visually inspect the NSTMs for deterioration, defects, damage, and cracks. Perform a hands-on inspection of all fatigue-prone details. A hands-on inspection is defined as the inspector being able to touch all surfaces of the tension carrying regions of NSTMs.
2. Clean suspect locations for better visual assessment and use appropriate non-destructive testing methods to verify potential crack locations and member thickness in deteriorated areas.
3. Photograph and sketch locations where deficiencies are found. Include appropriate dimensions and perspectives on all sketches. Close-up photographs must be taken before and after any

cleaning, paint removal, or testing. Include a photograph of the general location so others can understand exactly where close-up photographs were taken.

4. Confirm by using a checklist or other appropriate means that all NSTMs were inspected.
5. If a serious defect is found, notify the appropriate personnel immediately to determine what actions are necessary.

2.4.2.4.3 Hinges

A hinge in a steel girder is a location where bending moments are not transferred because of a pin and hanger connection or a rotational hinge connection system. A joint will be present in the deck at a hinge location. Hinges require careful inspection because of the complexity of the connection and the high stresses present.

2.4.2.4.4 Pin and Hanger Connections

A typical pin and hanger hinge configuration is shown in Figure 2.4.2-3. Pin and hanger connections are considered NSTMs when they are part of a two-girder or truss system. Because of the complexities of the connection and the high stresses present, pin and hanger assemblies must receive a close-up inspection as part of every scheduled Routine or NSTM inspection. Hanger links must be checked for out-of-plane bending. Retaining nuts must be checked for cracks and to confirm retaining nuts are tight. Verify the presence of cotter pins or tack welds to prevent retaining nut from backing off. Pins must be visually inspected for signs of corrosion. Pin/pin and hanger connections must be examined for evidence of movement of the hanger links off the ends of the pin, fracture of hanger links, misalignment or bowing of the hanger links (often from pack rust), bleeding rust stains, wear on the pins, or pin fractures. Because hinges are located at deck joints, leaking joints often promote corrosion in the hinge components. Pins are considered “frozen” when corrosion restricts rotation Thus, the assemblies can become bound due to corrosion of components, which can cause unanticipated tensile or torsional stress on the pins or bending stress on the hanger links. Often web plates at pin and hanger connections are stiffened and reinforced with web doubler plates to provide additional bearing area for pins. Doubler plates must be checked for pack rust that could apply an outward force to hanger plates and retaining nuts. Also, special requirements are needed for pins with retaining caps.

Pins for pin and hanger assemblies shall be ultrasonic tested on a 60 to 72-month frequency.

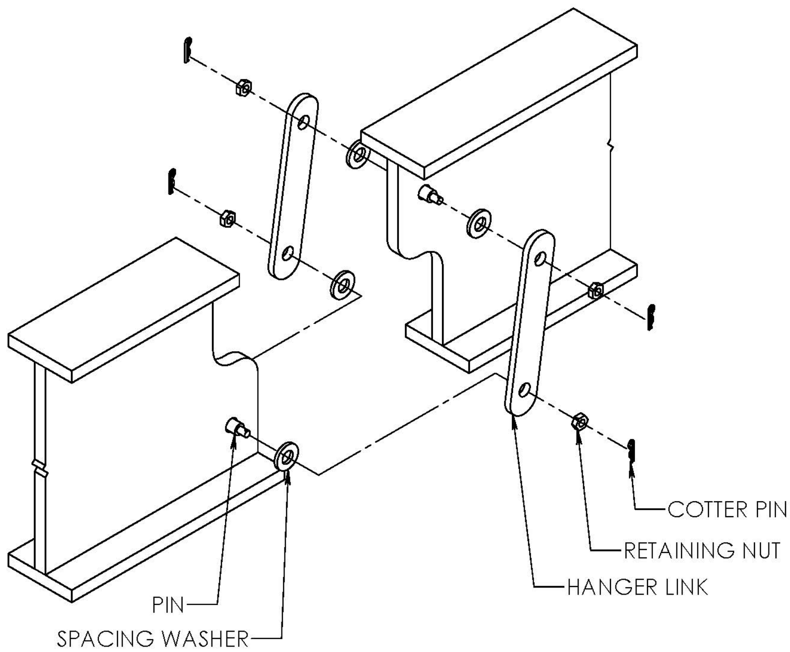


Figure 2.4.2-3 Pin and Hanger Hinge

2.4.2.4.5 Rotational Hinge Connections

A typical rotational hinge connection is shown in Figure 2.4.2-4. Rotational connections are considered NSTMs when they are part of a two-girder or truss system. Retaining nuts should be checked for cracks and to confirm retaining nuts are tight. Verify the presence of cotter pins or tack welds to prevent retaining nut from backing off. Pins should be visually inspected for signs of corrosion. Because hinges are located at deck joints, leaking joints can promote corrosion in the hinge components, including pack rust between the pin plates and the web plate. Pin plates should be checked for pack rust that could apply an outward force to retaining nuts.

Pins for rotational connection assemblies shall be ultrasonic tested on a 60 to 72-month frequency.

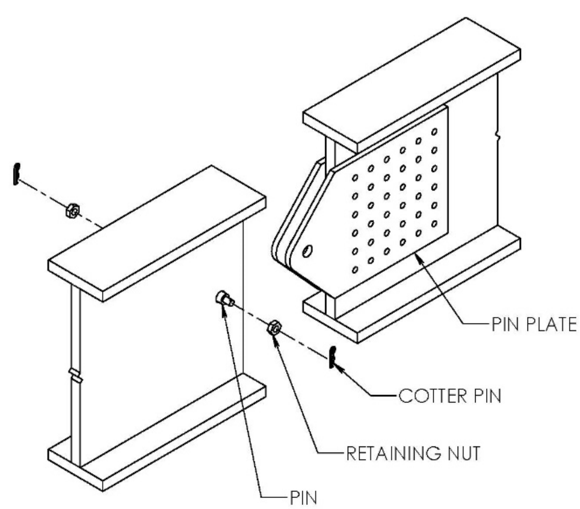


Figure 2.4.2-4 Rotational Hinge Connections

2.4.2.5 Other Structure Types

Many other superstructure types are less common on the Primary Highway System. The techniques used for inspecting these bridges do not vary greatly from what has been discussed previously. Unique aspects of some of the more common bridge types are discussed in the following sections. The FHWA Bridge Inspector's Reference Manual (BIRM) may also be used to provide additional inspection guidance and methods.

2.4.2.5.1 Timber

Timber beams must be inspected for checks, splits, knots, rot, and damage. Any of these conditions must be documented on a sketch.

Knots in timber stringers can be detrimental to the stringers' capacity. The area around a knot must be closely examined for splits.

2.4.2.5.2 Trusses

Truss bridges typically have NSTMs. The NSTMs must be identified by BSB. The truss tension members and floorbeams spaced at 14 feet or more are the most common NSTMs. Rotational Hinges and Pin and Hangers may also be NSTMs if they exist on a truss bridge. Gusset plates connecting NSTMs are also considered NSTMs.

2.4.2.5.3 Arches

An arch can be constructed with concrete or steel. Arches are designed to be mainly in compression but may experience tension under certain loadings.

A tied arch bridge has a main arch tied to a bottom chord at both ends of the arch. The bottom chord is in tension and is usually a NSTM.

2.4.2.5.4 Cable Supported Structures

The primary types of cable supported superstructures are cabled stayed and suspension bridges. Arch and tied arch bridges may also use cable members as suspenders to connect the deck framing system to the arch.

2.4.2.5.5 Rigid Frames

A rigid frame structure has the main superstructure girders integrally connected to the substructure to form a moment connection. These types of structures are less common and will be specifically identified in the bridge file.

2.4.2.6 Bearings

Bearings transfer the load from the superstructure to the substructure. They are designed to accommodate movement and/or rotation due to temperature and live load forces. There are four types of movement that could occur: 1) rotational, 2) longitudinal, 3) lateral, and 4) vertical. Vertical movement is normally due to earthquakes, which have a low probability of occurring in Iowa.

All bearings can accommodate rotational movement, but bearings are also designed to either accommodate or restrain longitudinal and/or lateral movement. Thus, bearings are defined on a plan set as either fixed or expansion. Fixed bearings accommodate rotation only, while expansion bearings accommodate rotation along with longitudinal movement. Special bearing types can accommodate lateral movement as well and are often found on wide bridges.

Typical bearing types are shown in Figure 2.4.2-5 through Figure 2.4.2-9.

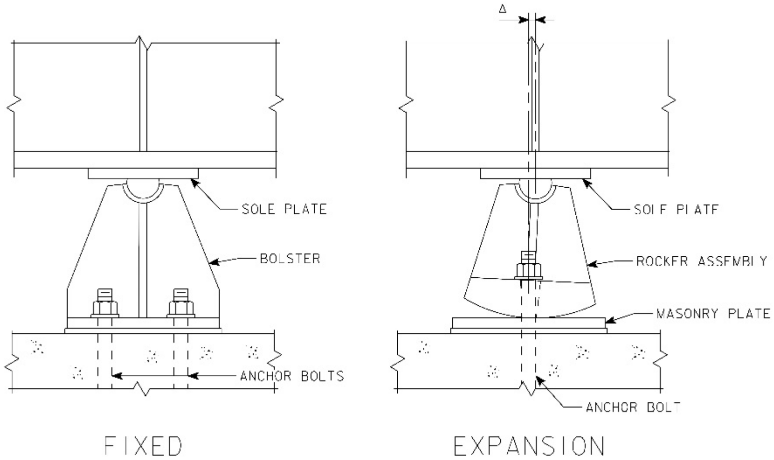


Figure 2.4.2-5 Steel Fixed Bolster and Steel Rocker Bearings

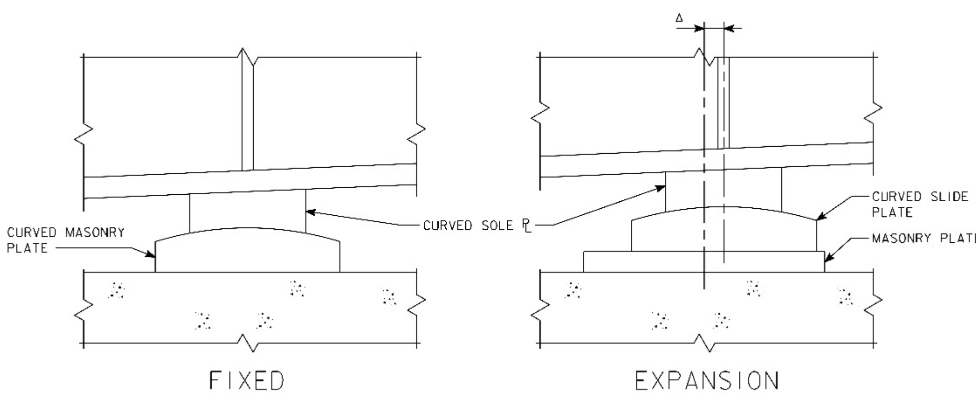


Figure 2.4.2-6 Steel Sliding Plate Bearings

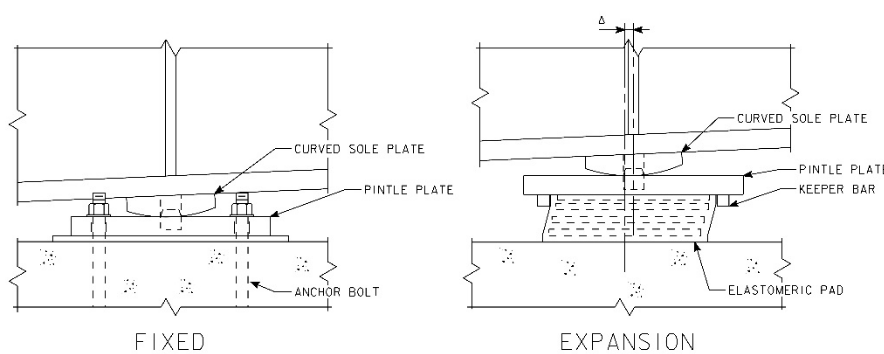


Figure 2.4.2-7 Pintle Plate & Pintle Plate with Elastomeric Pad Bearings

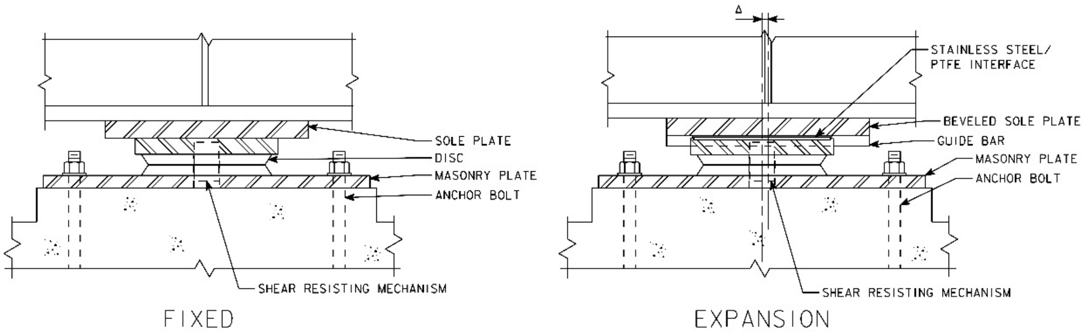


Figure 2.4.2-8 Disc Bearings

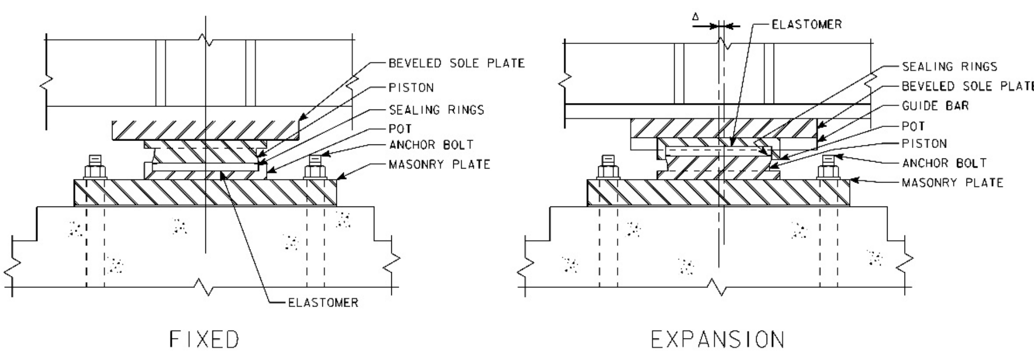


Figure 2.4.2-9 Pot Bearings

Expansion bearings are set at construction to a certain position according to the ambient temperature. These settings may or may not correspond to the temperature during the inspection. Movement of bearings is expected to be in expansion mode during the summer months and in contraction mode during the winter months. When movement is seen that does not correspond to the temperatures at the time of inspection, measurement of the bearing setting and the ambient temperature must be documented. Measurement locations for expansion bearings can be found in the figures of the bearing types shown above.

Any damage or deterioration of a bearing must be documented by sketches, photographs, or both. Pack rust that may be limiting the ability of the bearing to move properly must be noted. Bearings under deck joints are more susceptible to corrosion and pack rust because of joint leakage.

2.4.2.7 Coding SNBI B.C.02 (Superstructure Condition Rating) and B.C.14 (NSTM Inspection Condition)

The condition of bearings, joints, and paint system must not be included in the rating for SNBI B.C.02, Superstructure, except in extreme situations, but must be noted in the inspection report. On bridges where the deck is an integral part of the superstructure (such as concrete T-beams, where the deck is cast with the beams), the superstructure rating may be affected by the deck condition. If the deck is an integral part of the superstructure, the superstructure rating must not be higher than the deck rating. Both ratings (B.C.01 and B.C.02) must be the same for concrete slab bridges.

A condition rating of 5 or less requires a comment on the reasons for this condition rating.

The condition of all NSTMs will dictate the rating for SNBI item B.C.14. If there are NSTMs in both the superstructure and substructure, then report only the lower of the two condition values for item B.C14.

Table 20 in the SNBI is to be used to rate both of these items.

2.4.2.8 National Bridge Elements

The descriptions of the NBEs and their conditions states for superstructures can be found in the latest AASHTO MBEI Manual, including addendums.

1. When an element has defects in Condition States 3 or 4, the reviewers in the office will want to know more about the defect than just the square footage or quantity.
    a. Reports must include photographs and/or sketches that convey the extent and location of defects that are in Condition States 3 or 4.
    b. If a defect cannot be completely described with a sketch and/or photo, such as a bearing that moves under live load, an additional description must be included in the Reviewer's Comments field.
    c. Short descriptive locations of CS 3 & 4 defects in the Reviewer's Comments field may be helpful, such as "Bearing Loss at Pier 1" or "Spalling in Beam 3, see photo 26."

2.4.2.9 Additional SIIMS Superstructure Data

The Superstructure section in SIIMS has several items which are not part of the SNBI or NBE data. These items must be updated as necessary at each Routine or In-Depth Inspection.

2.4.2.9.1 Additional Structure Detail Fields

Some bridges have unique features not captured within the standard structure type codes of the SNBI or NBE. A field called "Additional Structure Details" has been created within SIIMS to document some of these special features. A drop-down menu of items is used to allow the selection of a special feature if one exists. The drop-down menu includes:

- Welded I Girder with Diaphragms (more than 2 girders) – Bridges with standard diaphragms between girder lines
- Two-girder Welded I Girder with Stringers – Standard two-girder bridges with stringers and floorbeams
- Two-girder Welded I Girder with Floorbeams – A two-girder bridge with floorbeams and no stringers
- Welded I Girder with Floorbeams (more than 2 girders) – Multiple girders with floorbeams supporting the deck
- Pony Truss – To specifically identify this type of truss bridge
- Arch Deck with No Fill – A concrete arch structure with no fill material between the arch and the deck
- Other – Any unique feature that would make the bridge necessary to include in a query

2.4.2.9.2 Beams/Girders

The SIIMS "Beams/Girders" section of the Superstructure Form has coding fields for identifying different types of interior and exterior concrete and steel beams/girders using drop-down options. Applicable fields also require condition coding of Good, Fair, or Poor and provide a comments box, as well. In addition, there is a check box to document how many beam ends are deteriorated, if any.

2.4.2.9.3 Diaphragms

The Diaphragms section in SIIMS is for documenting the type of diaphragms found on a bridge. A drop-down menu in SIIMS lists the choices of diaphragms to select from for end diaphragms and intermediate diaphragms. The choices are:

- Concrete – Solid concrete reinforced with mild steel
- Rolled Steel – A single rolled steel member, usually an I shape or channel shape
- Steel Angles – Multiple steel angles usually in an X-frame or K-frame configuration
- Miscellaneous – Any type not fitting the three other categories
- None – No diaphragms present

2.4.2.9.4 NSTM/Fatigue Prone /Fatigue Retrofit

The NSTM/Fatigue Prone / Fatigue Retrofit section in SIIMS is for documenting whether a bridge has NSTMs, Fatigue Vulnerable details, or if there has been a retrofit of a Fatigue Vulnerable detail. A "Yes" or "No" must be chosen from the drop-down menu for each of the three items. If "Yes" is chosen for any one of these features, the type of feature found on the bridge must be checked in the corresponding list. More than one item can be checked in any one list. If "Other" is checked, a description of the NSTM, Fatigue Vulnerable, or Retrofit must be entered in the comment box.

2.4.2.9.5 Fatigue Inspection History

A Fatigue Inspection is an inspection of the fatigue prone details of a steel member. This inspection is done during a Routine or In-Depth Inspection.

NSTM components with fatigue prone details, may require a Special Intermediate Fatigue Inspection at an interval between a Routine or In-Depth Inspection. A Special Intermediate Fatigue Inspection is required when a NSTM bridge has or has had fatigue cracks.

The Fatigue Inspection History section in SIIMS is for documenting the date of the last Fatigue Inspection and the date of the next Fatigue Inspection. Fatigue Inspections are scheduled on a 24- or 72-month basis. A bridge can be on a 72-month Fatigue Inspection frequency if there have never been more than two locations found with fatigue cracks, these fatigue cracks have been arrested, and the bridge does not have NSTM members. When more than two locations have had fatigue cracks verified, the bridge's fatigue-prone details must be inspected every 24 months. If the 72-month frequency is allowed, the check box designated as "Six Year Cycle" must be checked.

The number of locations with fatigue cracks shall be documented by entering the number of locations with the following:

- Previous confirmed cracks – total number of locations with cracks found during previous inspections
- New confirmed cracks – new cracks found during the current inspection
- Cracks extended beyond holes – old cracks with ¾-inch-diameter crack arrest holes that did not stop the crack from extending past the hole
- Confirmed cracks – the total number of crack locations currently found on the bridge regardless of if they have had ¾-inch diameter arresting holes drilled or large hole retrofits

If all cracks have been arrested with ¾-inch diameter holes or larger hole retrofits, "Yes" must be selected from the drop-down for the question "Have holes been drilled at all cracks?". Otherwise, "No" must be selected.

2.4.2.9.6 Pin and Hanger Inspections

To identify whether a Pin and Hanger assembly exists on the bridge, "Yes" or "No" must be selected from the drop-down menu. If there are Pin and Hanger assemblies on the bridge, the date of the last ultrasonic inspection and the date of the next ultrasonic inspection must be entered.

An ultrasonic inspection will be performed at a 60 to 72-month frequency. This inspection will be documented as a Special Pin and Hanger Inspection.

2.4.3 Substructure Inspection

Substructure members must be inspected for deterioration, as described below, due to specific material characteristics, as well as for signs of foundation settlement, rotation (tipping), lateral movement, overstress due to poorly functioning bridge bearings, scour, and undermining damage. During inspection for scour and undermining, areas surrounding the footings must be probed to find areas of loose backfill or areas where scour action has removed streambed material from around the footings. The most common cause of bridge failures is from floods, and the scouring of bridge foundations is the most common cause of damage to bridges during floods. Footings not located in areas influenced by stream flow may also experience undermining from bridge drainage outlets near substructure foundations. High stress zones of substructure members must be examined for localized failure at bearing pedestals and high shear and flexural zones.

2.4.3.1 Abutments

Abutments are located at the ends of the bridge and support the superstructure at the transition between bridge and pavement. Abutments can be supported by spread footings or piles. An abutment may be integral, semi-integral, or stub type.

Spalling, scaling, and cracking in the abutment seat and backwall concrete must be noted and sketched.

Undermining of the abutment must be noted and sketched. Undermining extending under the abutment to the point where the approach fill may be washing out from under the abutment is significant. Investigation of a possible void under the approach pavement is necessary. A void must be reported to BSB immediately to determine if it affects the safety of the roadway. The District may need to be contacted in severe cases.

If undermining has exposed steel piles, the piles must be examined for section loss as is practical. Section loss at the interface between the pile and footing is the most common place for this to occur.

2.4.3.1.1 Integral Abutments

An integral abutment is connected to the superstructure in a way that makes the abutment flex with the expansion and contraction of the superstructure. This flexing will often displace soil and create a trough in front of the footing and a void under the approach pavement at the paving notch. These conditions are not detrimental to the structure. The void under the approach must be monitored to make sure it does not grow too large due to water erosion.

2.4.3.1.2 Semi-Integral Abutments

A semi-integral abutment can be a retrofit or an original design. Leaching of subsurface drainage from the approach fill occurring between the footing and the backwall may be present, which may indicate a non-functioning sub-drain.

2.4.3.1.3 Stub Abutments

The backwall must be examined for signs of crushing or cracking from deck pressure against the backwall. The joint opening must be measured between the deck and backwall on the underside of the joint. The joint opening on top of the backwall may not be comparable to the gap between the deck and backwall underneath the joint.

The bridge seat must be examined for spalling, scaling, and delaminated areas. Spalling or scaling that has caused bearing loss must be measured and sketched.

2.4.3.2 Piers

There are many types of piers. They can be concrete, steel, or a combination of both. Steel pier caps can be NSTMs and require an arm's-length inspection.

Piers must be examined for signs of atypical movement. Settlement of pier foundations can cause tipping of the pier. Any unusual movement must be documented with a sketch and vertical alignment measurements.

2.4.3.2.1 Concrete Piers

Spalling, scaling, cracking, and delaminated areas of concrete must be documented with sketches and written descriptions of significant deterioration. Cracking in high stress areas must be documented.

Flood debris against a pier must be documented. Flood debris can increase the lateral forces exerted on the pier and can cause scour, which may lead to undermining of the pier footing.

2.4.3.2.2 Steel Bents

Steel bents must be checked for impact damage from flood debris. In addition, steel bent components and steel piles must be checked for fatigue cracking, pack rust, and section loss due to corrosion. Connections between primary vertical members and secondary bracing members must be checked for cracked welds, loose connections, or section loss at gusset plate connections.

2.4.3.2.3 Steel Pier Caps

Steel pier caps must be checked for signs of overstress at high shear or flexural zones. For NSTMs, an "arm's length" inspection of all components and connections must be conducted.

2.4.3.3 Underwater Inspection of Substructures

Substructure elements below the waterline are to be inspected by means of wading or probing at periods of low water.

Underwater Inspections are required when the low water depth is never below 2 feet. Underwater Inspection requirements include the following:

- If the water depth at low water is not less than 6 feet, divers are required to perform the inspection of underwater portions of the substructure. The Underwater Inspection by divers must be coded as "Yes" for SNBI Item B.IR.03 (Underwater Inspection Required).
- When the water depth is between 2 feet and 6 feet, wading and probing are used to inspect the portions of the substructure underwater. It is at the inspector's discretion whether a boat is used if the water level and current are too dangerous for wading. These inspections are to be performed at a 48-month frequency unless a reduction is warranted. SNBI Item B.IE.01 (Inspection Type) must be coded as 3 for Underwater Inspection and "Yes" for SNBI Item B.IR.03 (Underwater Inspection Required).
- The streambed must be documented during Underwater Inspections to the extent practical.
- SNBI Item B.C.15, Underwater Inspection Condition, must be rated considering only the underwater portion of inspected elements, and this code must be independent of any other ratings or defects which are not part of the underwater inspection.

Dive operations are to comply with OSHA/USCG regulatory standards, as applicable.

2.4.3.4 Coding SNBI Item B.C.03 (Substructure Condition Rating)

The substructure condition rating shall be made independent of the deck and superstructure. This item describes the physical condition of piers, abutments, piles, footings, or other components. The Scour

Condition Rating (SNBI Item B.C.11) may have a significant effect on the Substructure Rating (SNBI Item B.C.03) if scour has substantially affected the overall condition of the substructure. When the Scour Condition Rating is coded 2 or less, the Substructure rating shall be coded 2 or less.

Integral-abutment wingwalls up to the first construction or expansion joint shall be included in the evaluation. For non-integral superstructure and substructure units, the substructure shall be considered as the portion below the bearings. For structures where the substructure and superstructure are integral, the substructure shall be considered as the portion below the superstructure.

A condition rating of 5 or less requires a comment on the reasons for this condition rating.

2.4.3.5 National Bridge Elements

The descriptions of the NBEs and their conditions states for substructures can be found in the latest AASHTO MBEI Manual, including addendums.

When an element has defects in Condition States 3 or 4, the reviewers in the office will want to know more about the defect than just the square footage or quantity.

1. Reports must include photographs and/or sketches that convey the extent and location of defects that are in Condition States 3 or 4.
2. If a defect cannot be completely described with a sketch and/or photo, such as bearing movement/pumping under live load, additional description must be included in the Reviewer's Comments field.
3. Short descriptive locations of CS 3 & 4 defects in the Reviewer's Comments field may be helpful, such as "spalling of the cap beam undermines the bearing."

2.4.3.6 Additional SIIMS Substructure Data

The Substructure section in SIIMS has several items that are not part of the SNBI or NBE data. These items are to be updated as necessary at each Routine or In-Depth Inspection.

2.4.3.6.1 Foundation

The foundation types for the near and far abutments must be identified by using the most relevant type from the drop-down menu under the Description heading.

If the foundation elements are not visible, the condition must be coded as unknown. When the foundation elements are visible, the condition must be coded as Good, Fair, or Poor. If a Poor condition is found, a description of the condition must be entered in the comment field.

2.4.3.6.2 Berm Protection

The berm types for the near and far abutments must be identified by using the most relevant type from the drop-down menu under the Description heading.

The condition must be evaluated as Good, Fair, or Poor. If a Poor condition is found, a description of the condition must be entered in the comment field.

2.4.4 Channel Inspection

Channels must be inspected for the physical condition associated with the flow of water through the bridge, such as stream stability, and the condition of the channel, riprap, slope protection, or stream control devices, including spur dikes. The inspector must be particularly concerned with visible signs of excessive water velocity, which may contribute to undermining of slope protection, erosion of banks, and realignment of the stream, which, in turn, may result in immediate or potential problems. Accumulation of drift and debris on the superstructure and substructure must be noted in the inspection report but shall not be included in the condition rating.

2.4.4.1 Coding SNBI Item B.C.09 (Channel Condition Rating)

The Channel Condition Rating (SNBI Item B.C.09), must reflect the general condition of the channel at the bridge site in relation to the following:

1. Bank vegetation's ability to protect the embankments (i.e., channel action exposing/undermining root systems, trees leaning due to undermining, etc.).
2. Debris in the channel restricting flow – Debris could cause scour to occur around substructure elements.
3. Trees and brush restricting the channel – Trees and brush could cause a restriction accelerating the flow and the potential for stream degradation or scour.
4. Degradation or aggradation of the streambed – Streambed elevations significantly different than the as-built condition may cause unexpected problems during high water events.
5. Channel movement away from the as-built condition – Channel movement may encroach on the substructure or approach pavement, causing undermining and potential failure of the bridge or roadway.

A condition rating of 5 or less requires a comment on the reasons for this condition rating.

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

The rating for SNBI Item B.C.10, Channel Protection Condition Rating, must reflect the general condition of any channel protection devices. Channel protection devices are considered countermeasures that control, inhibit, delay, or minimize stream instability and scour problems, including river training and armoring countermeasures. Consider the following:

1. River control devices – Devices include spur dikes, jetties, retards, weirs, and other control systems.
2. Armoring countermeasures – Countermeasures may include rock riprap, grouted riprap, concrete slope paving, articulating concrete blocks, gabion mattresses, and grout-filled mats.
3. Bank vegetation – Vegetation protects the banks from erosion by normal water flow

A condition rating of 5 or less requires a comment on the reasons for this condition rating.

2.4.4.3 Coding SNBI Item B.C.11 (Scour Condition Rating)

SNBI Item B.C.11 is entered by inspectors to document any field-observed scour conditions and the effect of those conditions on bridge components. When determining the scour condition ratings, inspectors shall consider available data which may include design scour depth and critical scour depth which are commonly found in hydraulic designs, scour evaluations, scour POAs and new bridge plans. Iowa's Hydraulics group is developing guidance to help inspectors rate this. When observed conditions are not consistent with the scour design or the assumptions used in the scour appraisal, this indicates a need to reevaluate Item B.AP.03 (Scour Vulnerability).

2.4.4.4 Coding SNBI Item B.AP.03 (Scour Vulnerability)

SNBI Item B.AP.03 and the Scour Critical Classification are to be entered by the hydraulic engineers only. If scour is found at the inspection, the QC team or a reviewing engineer will send the inspection report for a hydraulic team review. After the hydraulics team has completed their review, they will make a recommendation for coding SNBI Item B.AP.03 and required repairs when they send the report back to Office Review.

2.4.4.5 Additional SIIMS Channel Data

The Channel section in SIIMS has several items not part of the SNBI or NBE data. These items must be updated as necessary at each Routine or In-Depth Inspection.

2.4.4.5.1 Bank Protection

The type of bank protection present upstream and downstream, if any (spur dike, jetty, retard, other, or none), must be described.

The conditions of the protection devices must be described as follows:

- Good – functioning and no damage to device
- Fair – functioning but minor damage to device
- Poor – not functioning properly due to damage to device
- N/A **-** no bank protection device

2.4.4.5.2 Revetment

The type of revetment present, if any (riprap, concrete, other, or none), must be described.

The conditions of the revetment must be described as follows:

- Good – functioning and no damage
- Fair – functioning but minor damage
- Poor – not functioning properly due to damage
- Blank – no revetment present

2.4.4.6 Underwater Inspection

Complete the following information for bridges that cross a waterway feature:

1. The “Underwater Inspection by Divers” (SNBI B.IR.03) must be coded as “Yes” when the low water depth is 6 feet or more. Enter “No” if divers are not required.
2. The streambed must be documented for scour, flood debris, constriction, etc., during Underwater Inspections to the extent practical. Channel bed measurements must be taken as directed per the Channel Bed Measurement Form in SIIMS. The “Streambed” must be coded “Yes” when it can be documented during the Underwater Inspection. Enter “No” when the streambed cannot be documented during the Underwater Inspection.
3. The number of piers that require Underwater Inspection must be documented. Only piers in low water deeper than 2 feet are to be included. Enter “0” when there are no piers requiring Underwater Inspection.
4. The SIIMS Underwater Inspection form has fields for documenting the following:
   - Team Lead and Inspection Date
   - Inspection methods used (i.e., SCUBA, SSA, Wading, Sounding, Imaging, Hydrographic Survey or Other)
   - Waterway conditions at time of inspection (i.e., Max. Water Depths, Visibility and Velocity)
   - Waterway datum information (i.e., Benchmark Location, Elevation and Water Surface Elevation)
   - Open comment fields for Inspection Summary, Scour and Channel Findings / Evaluation, Structural Findings / Evaluation, Recommendations, and Inspection Procedures

- Check boxes for various Risk Factors such as Rapid Stream Flow, Significant Debris Accumulation, Constricted Waterway Opening, Meandering Channel, Soft or Unstable Streambeds or Other
- Open comment field to describe Access Information or Special Considerations
- Data fields to enter data associated with submerged portions of NBEs such as Element #, Total Quantity Underwater, Units and CS1 thru CS4 distribution
- Data fields to identify the Substructure Units in water, Foundation Type, Bottom of Foundation and Scour Critical Elevations and Condition Rating

2.4.4.7 Channel Cross Section

A channel cross section on the upstream side of the bridge is required to be a part of the bridge record. Channel cross section must be updated every inspection. Cross section measurements must be taken at regular locations along the upstream fascia. If scour along a substructure unit (pier/abutment) exposes a footing, channel measurements must be taken at regular intervals along the length of the affected substructure unit. Consideration must then be given to performing a bathymetric/grid survey of the channel bottom when Scour Condition Rating (SNBI Item B.C.11) has a condition rating of 4 or less. For instances of excessive stream migration, a plan view of the channel must be generated that shows the upstream channel alignment, downstream channel alignment, and channel alignment with respect to substructure units.

A standard Channel Cross Section form has been incorporated into SIIMS. Each bridge structure is required to have data points at the top of bank, toe of bank, thalweg, and each substructure unit. The Channel Cross Sections are updated in SIIMS for natural waterways.

Drainage ditches controlled by a drainage district will not require cross section updates unless conditions at the bridge warrant more frequent monitoring.

Although the Channel Cross Section is required in SIIMS, hand-drawn channel sketches may be uploaded to the report, or the standard Channel Cross Section form in SIIMS may be used to generate a channel cross section sketch where the potential for and/or real time damage to the bridge substructure exists.

The channel cross section should be used to calculate SNBI Item B.G.13 (Maximum Bridge Height) which is the maximum vertical distance from the top of deck down to the ground or water level measured along the length of the bridge.

2.4.5 Culvert Inspection

A culvert with an opening greater than 20 feet as measured along the center of the roadway is considered a bridge-sized structure and is subject to NBIS requirements. Similarly, a grouping of culverts with a length greater than 20 feet as measured along the roadway centerline, and where the clear distance between openings is less than half the smaller contiguous opening, is considered a bridge-sized structure.

Culverts must be inspected for their overall condition, any approach roadway and embankment settlement, the condition of their end treatments (headwalls, parapets, and wingwalls), and the condition of their appurtenance structures (such as aprons, weirs, and energy dissipaters). The inside of a culvert must be inspected for any damage or deterioration. Weep holes must be checked to determine if they are functioning or if they are plugged. Joints must be checked for deterioration or spalls.

2.4.5.1 Concrete Headwalls, Wingwalls, Cut-off Walls and Aprons

The following items must be reviewed at each inspection:

1. Wall condition – wall tipping, cracking, and concrete scaling
2. Apron condition – concrete scaling, settlement, cracking, and undermining
3. Cut-off wall – stream bottom elevation, undermining, piping of water under or around the cut-off wall, and riprap present

2.4.5.2 Concrete Barrels

For concrete barrels, the following items must be reviewed at each inspection:

1. Wall condition – cracking, spalling, scaling, joint openings, and bulging
2. Slab condition – cracking, spalling, scaling, joint openings, and leaching
3. Floor condition – sediment depth, spalling, scaling, settlement, and heaving

2.4.5.2.1 Silt Accumulation

The inspection shall include documentation of siltation in culvert barrels. If a barrel is more than half full, the situation will be reviewed by the Preliminary Bridge Design Unit before the inspection is finalized.

Figure 2.4.5-1 Silt Accumulation

2.4.5.2.2 Metal Culverts

For metal culverts, the following items must be reviewed at each inspection:

1. Corrosion – section loss
5. Erosion – potential piping around the culvert
3. Distortion – unusual defections or alignment
4. Connections – loose or missing bolts; separated/misaligned seams that allow dirt infiltration or exfiltration

2.4.5.2.3 Silt Accumulation

The inspection shall include documentation of siltation in culvert barrels. If a barrel is more than half full, the situation will be reviewed by the Preliminary Bridge Section before the inspection is finalized.

2.4.5.3 Concrete Arch Culverts

For concrete arches, the following items must be reviewed at each inspection:

1. Footings – scour, cracking, spalling, and pile exposure
2. Arches – spalling, scaling, exposed reinforcing, conditions at the spring line
3. Wingwalls – wall tipping, cracking, and concrete scaling
4. Fill – signs of settlement, sink holes, and pavement settlement

2.4.5.4 Fill Depth

The fill depth must be measured for all culvert types. This information is needed for dead load calculations used for the load rating. Update and/or verify the sketch of the cross section of the culvert with the elevations of the fill at the parapets, roadway shoulders, and centerline of roadway when there are roadway changes or extensions are constructed. The maximum fill depth must be documented on the sketch if it is different from the recommended elevation locations described.

2.4.5.5 Coding SNBI Item B.C.04 (Culvert Condition Rating)

The Culvert Condition Rating (SNBI Item B.C.04) must evaluate the alignment, settlement, joints, structural condition, scour, and other elements associated with culverts. The rating code is intended to be an overall condition evaluation of the culvert. Integral wingwalls to the first construction or expansion joint shall be included in the evaluation.

A condition rating of 5 or less requires a comment on the reasons for this condition rating.

2.4.5.6 National Bridge Elements

The description of the NBEs for culverts can be found in the latest AASHTO MBEI Manual, including addendums.

1. When an element has defects in Condition States 3 or 4, the reviewers in the office will want to know more about the defect than just the square footage or quantity.
    a. Reports must include photographs and/or sketches that convey the extent and location of defects that are in Condition States 3 or 4.
    b. If a defect cannot be completely described with a sketch and/or photo, such as deterioration of the culvert floor because of deep water, additional description must be included in the Reviewer’s Comments field.
    c. Short descriptive locations of CS 3 & 4 defects in the Reviewer’s Comments field may be helpful, such as “Reinforcement is exposed in the floor of barrel #1” or “Spalling at bottom of the near wall below the flow line in barrel #2, see photo 26.”

2.4.5.7 Additional SIIMS Culvert Data

The Culvert section in SIIMS has items not part of the NBE or SNBI data. These items must be updated as necessary at each Routine or In-Depth Inspection.

2.4.5.7.1 Fill

There is a check box that must be checked when no fill is present over the top of the culvert. This identifies culverts for which the top of the slab is the driving surface of the roadway.

2.4.5.7.2 Revetment

The type of revetment present, if any (riprap, concrete, other, or none), must be described.

The overall condition of the revetment must be described as follows:

- Good – functioning and no damage
- Fair – functioning but minor damage
- Poor – not functioning properly due to damage
- Blank – no revetment present

If the condition is considered Poor, a description of the condition must be entered into the comment field.

2.5 SIIMS DOCUMENTATION

(Note: Some of this section will be superseded by Chapter 6, when it is developed and published.)

2.5.1 About SIIMS

The Structure Inventory and Inspection Management System (SIIMS) is the single-source location for entering and reviewing condition information for all Iowa bridges, both State owned and locally owned. In order to use SIIMS, a user must be registered in SIIMS by completing a form for a Bridge Owner, Bridge Inspector, Bridge Load Rating Engineer, or Bridge Data Entry Personnel. Individuals who do not qualify for any of these levels of access must complete a form for Bridge Information. The various permission levels control the level of access provided within the system.

SIIMS has the ability to track all keystrokes made within the system based on the user. In this way, the software can determine the source of any information changed or edited within the system. For this reason, it is important a user does not share their user ID or password with anyone else.

The architecture of the SIIMS software includes several main menus with pulldown submenu items on the homepage which are as follows:

- **MAIN**: Dashboard, My Account, My Preferences, My Working Set, API Key Management, Change Password, Logout and My Email Alerts.
- **COLLECTOR**: Report Filter, Inspection Schedules, Report Summary View, Collection Dashboard, Merge Reports, Upcoming Inspections, Archived Assets and Bulk Report Workflow Change.
- **MAINTENANCE**: Maintenance Filter and Dashboard, Manage Maintenance by Asset, Work Orders and Bulk Maintenance Workflow Change.
- **MANAGER**: Dashboard, Main Map, Management Reports, Query, Sufficiency Ratings and Data Extractor.
- **HELP**: Product Manual, About, Documentation, Bentley Communities and Release Notes

2.5.2 Manager Menu in SIIMS

The Manager menu is geared toward Program Managers for bridge inspection programs at either the State or local level. Access to the Manager menu is limited based on permissions granted. For example, the Program Manager for a local agency may be granted permission to access bridge inspection data only for bridges under their jurisdiction. Functions within the Manager menu include queries to search for data and mapping options (for example, to display all bridges within a particular county). Through the menu, the user also has the ability to provide system reports used to support funding decisions for a local agency's bridge program.

2.5.3 Collector (Inspector) Menu in SIIMS

The Collector menu allows an inspector to filter and view the bridge inspection report status, workflows, and upcoming inspections. Access to the Collector menu is limited based on permissions granted. For example, an inspector for a local agency will only be granted permission to access bridge inspection information for bridges under the jurisdiction of the given local agency. The Collector menu allows inspectors to organize and view the bridges they are tasked with inspecting.

2.5.4 Creating Inspection Reports

New reports can be created and pending reports can be viewed or edited based on the status of the report. To create a new report, the inspector must navigate to the specific bridge needing inspection and click the Create Report button. When a user is creating a new report, historical information from the bridge file, such as the bridge plans, will automatically be associated to the bridge from information in the Central Database. In addition, when creating a report, the user must specify the report type (for example, SNBI-State, SNBI-LPA). Once the report type is chosen, the Inspection type can be selected from the list shown. **Important Note** – Do not create a new report if there is already one open.

2.5.5 Bridge Descriptions in SIIMS

The Bridge Descriptions tab in SIIMS provides written descriptions of what an inspector must expect to see when arriving at a bridge. As such, the descriptions must be of the configuration of the bridge, not the condition of the bridge. The descriptions must include rough dates of when the bridge and bridge components were built, retrofitted, or repaired. If the date of a change to a bridge or bridge component is unknown, the description must indicate when the change was first recorded, such as: “Retrofitted rectangular concrete bridge rails were installed sometime prior to the 1991 inspection.”

2.5.5.1 General Guidelines for Written Descriptions

In general, describe permanent and long-term features of the bridge, such as overlays, retrofitted barrier rails, beam replacements, paint, abutment backwall rebuilds, paving notch rebuilds, riprap installations, and articulated block mat installations. When describing a change, retrofit, or addition, include the year when the new feature was first included.

Conversely, do not list Design Numbers or FHWA Bridge Numbers in the descriptions. The descriptions are not intended to describe maintenance features, such as Portland cement patches to the deck or epoxy injection of the deck. In addition, they would not describe deterioration such as spalls or impact damage.

2.5.5.2 Descriptive Information Required for Subsections

2.5.5.2.1 Bridge Description

Describe the bridge size (length and width), the superstructure type, and the bridge location. The location information must describe the feature the bridge is crossing over, such as “…carrying westbound I-80 over Mud Creek 1.5 miles west of US-65.”

2.5.5.2.2 Waterway

Indicate the skew of the waterway in relation to the bridge and the direction of the skew (right-hand back or left-hand back). Describe the upstream channel characteristics related to the stream path.

2.5.5.2.3 Roadway Under Bridge

List the name of the route under the bridge. List the span(s) the route passes through as it goes under the bridge.

2.5.5.2.4 Substructure

Describe the type of abutments for the bridge. Describe the number of piers and the type(s) of piers. Describe which piers use fixed and which piers use expansion bearings.

2.5.5.2.5 Superstructure

Indicate the number of spans in the bridge. Describe the type of girder used. Describe any special features of the superstructure, such as fatigue vulnerability and list the details of the special features.

2.5.5.2.6 Culvert

Indicate the number of barrels for the culvert, and the height and width of each barrel. Indicate the skew of the culvert relative to the roadway and the direction of the skew (right-hand back or left-hand back). Describe the type of headwalls used (straight or flared).

2.5.5.2.7 Roadway

The description of the bridge roadway refers to the bridge deck. Describe the roadway material type. Include the type and year of installation of the overlay if one exists.

2.5.5.2.8 Approaches

Describe the type of pavement used on the bridge approaches. If an overlay exists on the approach roadway, describe the type of overlay and the year it was installed. Describe any maintenance performed on the approach pavement.

2.5.6 Calculated SNBI Items

Calculated fields are recalculated and updated in SIIMS during entry of inspection data for a new inspection. The logic for the calculated appraisal ratings can be reviewed in the SNBI Calcs section in SIIMS. It is recommended that these ratings be recalculated by choosing “Recalculate SNBI Ratings” in the SNBI Calcs section of SIIMS before finalizing an inspection.

The data fields that are calculated in the SNBI Calcs section in SIIMS are:

1. SNBI Item B.C.12, Bridge Condition Classification
2. SNBI Item B.C.13, Lowest Condition Rating Code
3. SNBI Item B.G.16, Calculated Deck Area.
4. SNBI Item B.IE.06, Inspection Due Date

2.5.7 Photographs, Sketches, Plans, Documents, and Files

Photographs, sketches, plans, documents, and files are viewable under the File tab in SIIMS. Almost any file type can be added to a bridge file. The type of document will determine whether the document must be attached with an inspection report or as part of the Bridge File. If a document relates to only a specific inspection, such as photographs and sketches, it must be attached to the “In Progress” inspection report. When a document relates to the bridge, such as design plans or a scour plan of action, the document must be attached in the “Files” area under the appropriate file type on the Asset Details page.

Files attached as part of an inspection report must be attached before the inspection report is finalized. If a document or file is not attached before the inspection report is finalized, the report must be unapproved to attach the files and then reapproved.

Files not related to an inspection can be attached on the Asset Details page under the File tab at any time, whether an inspection is in progress or not. The description field for each document must include specific information about the subject of the document so anyone looking at the Bridge File will know what each document contains without having to open each document.

2.5.7.1 Required Photographs

For Routine Inspections, the following photographs are required:

1. Bridges
    a. Approaches, with and against the route direction
    b. Profile view
    c. Upstream and downstream views, when over water
    d. Both abutments (overall)
    e. Typical pier, including one of each type if there are multiple types
    f. Bottom of the deck overall to show girder type and configuration
    g. Top of deck overall
    h. All deck joints
    i. Guardrail overall
    j. Load Posting Signs
    k. Vertical Clearance Signs
    l. Approach Warning Signs
    m. CS3 or CS4 deficiencies
2. Culverts
    a. Both inlet and outlet profiles
    b. Roadway above
    c. Upstream and downstream views
    d. Typical interior of culvert/barrel when accessible
    e. CS3 or CS4 deficiencies
    f. Any condition that may warrant repair

In-Depth Inspections must include all the required photographs for a Routine Inspection as well as photographs relating to the field notes on deteriorated or unique conditions. In addition, photographs of the posting signs must be included in the report. Structures with a condition rating coding of 4 or less for Deck (SNBI Item B.C.01), Superstructure (SNBI Item B.C.02), Substructure (SNBI Item B.C.03), Channel (SNBI Item B.C.09), or Culvert (SNBI Item B.C.04) are required to have photographs of the deficiency, although it is good practice to photographically document any significant deficiency. Add photographs that impact/control the condition ratings either singularly or as a combination with other deteriorated contributing elements.

2.5.7.2 Photograph Annotation Convention

The description field for each photograph must include specific words so that photos of unique circumstances can be found in future queries. These key words do not have to be used in any specific order or consecutively. A query will look for any combination of these words in a description. Common key words that may be used to find photographs of a particular issue are shown in Table 2.5.7-1.

Table 2.5.7-1 Common Photo Caption Key Words

Component	Label	Element or Portion	Typical Defects
Approach	Near / Far	Pavement Guardrail	
Profile	Right / Left		
Barrier Rail			Spall / Scaling / Damage
Curb/Sidewalk	Left / Right		Spall / Scaling
Deck		Top Bottom Fascia Joint	Spall / Hollow Spall / Hollow Spall Deterioration
Superstructure		Paint	Peeling
		Beam Ends	Spall / Hollow / Rust
			Crack Retrofits
			Intersecting Welds
			Fatigue Cracks
			Rust / Section Loss
Abutment	Near / Far	Bearing	Deterioration / Tipping
		Pile	Deterioration
		Backwall	Spall / Scaling / Cracking
		Wing	Spall / Scaling / Cracking
Piers	1 / 2 / 3 ……	Bearing	Deterioration / Tipping
		Column	Spall / Scaling / Cracking
		Cap	Spall / Scaling / Cracking
Waterway	Upstream / Downstream		

2.5.7.3 Sketches

Sketches must be scanned into a single multi-page PDF file before attaching them to an inspection report. If there is a large number of sketches to attach for a given bridge, the sketches can be grouped in logical pieces and attached as independent groups of sketches. When several groups of sketches are to be attached to an inspection report, each PDF file must include a description identifying the type of sketches that are in each group. Logical groupings are:

- Profile
- Substructure
- Superstructure
- Deck

2.5.7.4 Plans

The original design plans as well as any repair or rehabilitation plans are to be attached to a bridge file in the Manager's module. Each plan set must be in a single file. If a bridge was built with staged construction, each stage can be attached individually. Each plan set must include a description of the details of the plans. The description must include the general work type and whether the plans are the "As-Built" set.

2.5.7.5 Other Documents

Any other documents relating to an inspection or the bridge in general can be attached under the following groupings:

1. Files – General documents: correspondence, material test reports, load test reports, etc.
2. Map – An aerial map
3. Load Ratings – Load Rating calculations
4. Scour – Scour calculations, Plans-of-Action, flood data, etc.
5. NSTMs – Documentation of the elements that are NSTMs as required by the NBIS
6. Channel Sections – Channel sketches showing changes in channel profile
7. Audio – Any audio or video recordings

2.5.8 Critical Findings

Reporting of Critical Findings is required under the NBIS. Critical Findings are structural or safety-related deficiencies requiring immediate follow-up inspection or action. Typically, a Critical Finding requires bridge closure or lane closure. A form has been set up for documenting the finding and the follow-up actions. This form can be completed as part of any inspection. The form must be completed as soon as possible from the time of the finding.

A complete description of the Critical Finding and the immediate action taken must be included in Part I of the form. Once the situation has been assessed, Part II of the form must be completed. Part II must include the proposed resolution of the Critical Finding and the time frame anticipated for completion.

The procedures to be used when issuing a Critical Findings Report are as follows:

1. The individual discovering the critical finding shall share this with the Team Leader on site to:
   a. Immediately report the finding to the BSB, who will notify maintenance personnel to take appropriate action which may require closing or restricting traffic on the bridge.
   b. Complete Part I of the Critical Findings Report within 48 hours of the finding.
2. The BSB shall:
   a. Take action to ensure the safety of the travelling public.
   b. Complete Part II of the Critical Findings Report within 5 days of the finding.
3. Before a closed bridge may be reopened to traffic, the following must be completed:
   a. A Professional Engineer, licensed in the State of Iowa, shall approve any structural repairs.
   b. The bridge shall be load rated.
   c. The bridge shall be inspected by a Team Leader.

2.5.9 Load Rating Documentation

2.5.9.1 Load Rating Evaluation Form

The Load Rating Evaluation Form must be completed for every inspection. This form will determine if the existing load rating needs to be re-evaluated to determine if it is still valid or if a new load rating is needed. The Evaluation Form can be filled out by the inspector or the QC reviewer. It is part of the error check process and must be filled out before the report can be finalized. The date they complete it must be entered at the top of the form.

Most questions on the form default to “No.” The question at the top of the page and the question at the bottom of the page default to “blank” and must be answered at each inspection. If any one of the questions is changed to “Yes,” a re-evaluation of the load rating or potentially a new load rating calculation will be required. When the Load Rating Evaluation Form indicates re-rating or re-evaluation is needed, a Quality Control Team member will submit the inspection to the Load Rating section for review.

2.5.9.2 Load Rating Bridge Report

The load rating must be completed by a Professional Engineer licensed in the State of Iowa. As noted above, the need for a load rating re-evaluation or a new load rating calculation is determined by filling out the Load Rating Evaluation Form.

If the load rating is re-evaluated and there is no reason found to update the load rating, the following fields on the Load Rating Evaluation Form shall be updated:

1. **Name**: Engineer who performed the Load Rating re-evaluation
2. **Date**: The date the re-evaluation was completed
3. **Does the bridge need to be re-rated?**: Change the answer to this question to “No”
4. **Comment section:** Must provide an explanation as to why the bridge does not need a re-rating.

If the load rating is re-calculated and the ratings have changed, the entire Load Rating Bridge Report Tab must be updated. Also, on the Load Rating Evaluation Form the response to the first question “Was the bridge re-rated as part of this inspection?” must be changed to “Yes.” The Load Rating Bridge Report Tab can be generated by an unlicensed engineer, but a licensed engineer must put their name and license number at the bottom of the form. It is recommended the new calculations be attached to the inspection report before it is finalized. If the ratings are not completed before the inspection report is finalized, a Load Rating Bridge Report must be created to update the ratings and attach the calculations.

Load Rating data is to be coded in SNBI Subsection 5.1 – “Loads and Load Rating.”

2.5.10 Supplemental Inspection Information

The NBIS requires information on maintenance history be maintained for all bridges. The Supplemental Inspection Information section in SIIMS provides a means to document this information. Other information related to bridge inspections is also included on this page. Some items included are as follows:

1. Traffic control needs during inspection
2. Time requirements for inspection
3. Construction work history
4. Several SNBI location, geometry, and classification items

2.5.11 Maintenance, Repair, and Replacement

The Maintenance, Repair, and Replacement (MR&R) section in SIIMS is used to make recommendations for repair, rehabilitation, and replacement. The maintenance recommendations include all maintenance needs found during an inspection. When a recommendation has been completed, deferred, submitted for contract work, or programmed, this information is entered into SIIMS by district personnel or BSB personnel.

2.5.11.1 Maintenance Recommendations

When a recommendation is made, one of three check boxes must be checked to identify the type of recommendation. The three options are:

1. Corrective – The District must make the repair within 12 months or make provisions to have the work done by contract.
2. Preventive – Maintenance will prevent future deterioration. Deterioration is not causing a structural or safety issue at this time.
3. Monitor – The District must monitor the condition at an interval set by BSB or the District as appropriate.

A default type will be checked after the recommendation code is selected from the drop-down menu. This does not mean this is the only option for the recommendation. Some recommendation codes will display the Corrective and Preventive box checked. In this case, the severity of the condition must be used to determine which type of recommendation is made. One of the boxes must be unchecked before the report is finalized.

Recommendations made during an inspection but not yet completed will come forward at future inspections. If a past recommendation has not been completed and is still necessary, the recommendation must be left as it is. A duplicate recommendation is not appropriate. If additional deterioration is found and the recommendation needs to change to a different code, then the recommendation status must be changed to "Cancelled" and a new recommendation added.

Maintenance recommendations should be marked as "Completed" by the inspector or reviewing engineer when the maintenance has been found to be completed during inspection. "Cancellation and Deferral" decisions will be made at the District or BSB Management level.

2.5.11.2 Maintenance Recommendation Codes

The Maintenance Recommendation Codes currently available for bridge work are shown in Table 2.5.11-1. Recommendation codes 199, 299, 399, 499, and 599 are for situations not included in any of the available codes. The appropriate codes for Deck (199), Superstructure (299), Substructure (399), Channel (499), or Approach (599) work must be used. These codes can be used for Corrective, Preventive, or Monitoring situations.

Table 2.5.11-1 Maintenance Recommendation Codes

Code	Recommendation	Corrective or Preventive
Deck		
100	Remove gravel from approaches	P
101	Remove gravel from snow & ice	P
103	Clean deck drains	C
104	Clean deck & drains	C
105	Remove loose concrete - Bottom of deck	C
110	Spall patch - Minor	P
111	Spall patch	C
112	Spall patch - Major	C
114	Deck deterioration - Possible failure	C
121	Recommend PCC overlay	C
132	Replace - Urgent	C
140	Inject w/ epoxy	P

Code	Recommendation	Corrective or Preventive
141	Inject & patch spalls	C
142	Replace overlay	C
145	Repair Curb / Rail Spalls	C
150	Repair or replace sliding plate joint	C
151	Repair crumb rubber joint	C
152	Repair or replace strip seal gland	C
153	Pourable Joint Repair	C
160	Extend deck drains	C
161	Repair extensions	C
162	Seal concrete below drains	C
170	Paint steel handrail	C
171	Repair collision damage	C
172	Seal concrete handrail	P
199	Miscellaneous - Deck	C
Superstructure		
200	Clean superstructure	P
212	Spot paint - Schedule	P
213	Complete paint - Consider	P
214	Complete paint - Schedule	C
215	Zone paint - Severe rusting	C
221	Possible cracks - Drill	C
223	Loosen diaphragm bolts	C
230	Tighten loose bolts	C
232	Replace missing bolts	C
234	Tighten & replace	C
240	Repair - Spalls	C
241	Seal	C
249	Seal spalls	C
250	Repair spalls	C
251	Moisture - Seal	C
252	Cracks - Seal	C
260	Repair concrete diaphragms	C
261	Repair nicks & gouges	C
271	Repair collision damage	C
299	Miscellaneous - Superstructure	C
Substructure		
300	Clean bridge seats	P
301	Clean & paint bearings	P
302	Clean seats & paint bearings	P
303	Drain bridge seats	C
304	Re-set bearings	C
310	Repair near face & seat	C

Code	Recommendation	Corrective or Preventive
311	Repair far face & seat	C
312	Repair both faces & seats	C
313	Repair near backwall	C
314	Repair far backwall	C
315	Repair both backwalls	C
320	Repair cap & bridge seat	C
321	Repair columns	C
322	Repair bridge seat & columns	C
340	Repair culvert walls	C
371	Repair collision damage	C
399	Miscellaneous - Substructure	C
Channel		
400	Remove flood debris - Piers	P
401	Remove unbalanced fill - Piers	C
402	Cut off old pile in channel	P
403	Remove trees & brush	P
410	Repair erosion - Near berm	C
411	Repair erosion - Far berm	C
412	Repair erosion - Both berms	C
413	Repair erosion - Around near wing	C
414	Repair erosion - Around far wing	C
415	Repair erosion - Around all wings	C
416	Berm - Repair erosion - Near berm undermined	C
417	Berm - Repair erosion - Far berm undermined	C
418	Berm - Repair erosion - Both berms undermined	C
420	Repair degradation - Consider	P
421	Repair degradation - Schedule	C
422	Repair meander - Consider	P
423	Repair meander - Schedule	C
430	Remove flood debris	P
431	Repair erosion at outlet	P
433	Clean out - Schedule	C
440	Seal cracks	P
441	Seal cracks & repair - Consider	C
442	Seal cracks & repair - Schedule	C
499	Miscellaneous - Channel	C
Approach		
500	Re-cut near pressure relief joint	C
501	Re-cut far pressure relief joint	C
502	Re-cut both pressure relief joints	C
503	Install near pressure relief joint	C
504	Install far pressure relief joint	C

Code	Recommendation	Corrective or Preventive
505	Install both pressure relief joints	C
510	Repair pavement - Near approach	C
511	Repair pavement - Far approach	C
512	Repair pavement - Both approaches	C
520	Repair shoulders - Near approach	C
521	Repair shoulders - Far approach	C
522	Repair shoulders - Both approaches	C
523	Repair near concrete panels	C
524	Repair far concrete panels	C
525	Repair all concrete panels	C
530	Guardrail repair near end	C
531	Guardrail repair far end	C
532	Guardrail repair both ends	C
571	Guardrail - repair collision damage	C
599	Miscellaneous - Approach	C

2.5.11.3 Program Recommendations

The Program Recommendations section in SIIMS is for work that cannot be done by District forces. This section can be populated by BSB inspection staff or District staff. There can be three separate recommendations for contract work at one time. Separate work items must be used when the work needed will not be performed by one contractor. An example of separate work items is painting, deck overlay, and riprap. In contrast to this, work items that can be performed by one contractor must all be included in one work item and comments must be made in the "Description of Work/Comments" listing the work needed. When there is more than one work item, an "Importance" can be selected to designate which work item is the highest priority among the work items designated for that bridge.

When entering a new Program Recommendation, include the preliminary cost estimate, the proposed date, whom the work is proposed by, and the priority of the work. This will place the bridge in the list to be evaluated at the annual District meeting with BSB. At the annual meeting, the project will be discussed and a determination of "Official Candidate" status, priority of work, and preliminary cost estimate will be made.

The Program Recommendation Items available are:

- Riprap
- Bridge Rehabilitation
- Bridge Removal
- Bridge Replacement
- Bridge Widening
- Bridge Approach Repair
- Bridge Deck Overlay
- Bridge Repair
- Bridge Rail Retrofit

- Bridge Painting
- Culvert Replacement
- Culvert Repair
- Culvert Extension
- Bridge Cleaning/Washing
- Deck Joint Repair
- Bridge Slope Protection
- Permanent Scour Countermeasures
- Deck Patching with PC Concrete
- ‘Temporarily’ Repair Top of Abutment Backwall
- Replace Neoprene Expansion Joint Gland
- Rehab End of Prestressed Beam
- Replace Existing Joint w/ Strip Seal Joint
- Repair (not replace) Barrier Rail
- Repair Bridge Curb
- Repair Components of Modular Joint
- Replace Bridge Approach Pavement
- Replace Pavement Notch & Bridge Approach Pavement
- HMA Resurface Bridge Approach Pavement
- Patch Substructure Members
- Clean/Wash Deck & Unplug Drains
- Barrier Rail Sealing

A Program Recommendation can be entered as part of an inspection report or by navigating to a bridge record and opening the Asset Info tab in SIIMS. Program Recommendations are always active and are not necessarily associated with a specific inspection.

The “Need for Project Statement” is for the use of BSB. This statement will be used in the concept and is requested when the concept is being written. The “Need for Project Statement” must include specific information about the bridge and reasons for needing the project. The Load Rating Engineer in the Bridge Maintenance and Inspection Unit normally enters the “Need for Project Statement.”

Once a Project has been let to contract, the status of the proposed work item must be changed to “Completed.” The Assistant District Engineer must update the status after letting. The status can be updated to “Completed,” “Programmed,” “Cancelled,” or “Deferred” at any time. Programmed status is when a project for the proposed work is included in the 5-year program.

Recommendations previously completed serve as maintenance history. The NBIS requires a maintenance history be maintained for all bridges. This is accomplished with SNBI Items in Subsection 7.5 – “Work Events” on the Supplementary Inspection Information page in SIIMS. Program recommendations should be marked as “Completed,” “Cancelled,” or “Deferred” by the District or BSB Management.

2.5.12 Inspection Report

An inspection report is made up of several sections from the inspection input areas. Each inspection report must include all appropriate input areas to create a final report. Not all sections need to be included in each report but may be needed for future inspections or as additional information after the inspection report is finalized. If a section is removed from the “Report Sections” screen, the section removed cannot be viewed or printed after the report is finalized. Sections that may be used in future reports must not be removed but can have the "Print" check box left blank. By leaving the "Print" check box blank, this section will not be included in the final report but can be viewed and printed individually.

Sections of the inspection report that can be removed are areas that will never apply to the given bridge. If a structure is a culvert, the Deck, Superstructure, and Substructure sections will never be used and can be removed. The Culvert section can be removed from a structure that has a Deck, Superstructure, and Substructure. The Channel section can be removed when the bridge is over another roadway.

When an In-Depth or Routine Inspection is performed, the sections outlined in Sections 2.5.12.2 and 2.5.12.3 of this manual must always be included in the report.

2.5.12.1 Error Check

The Error Check section can be reviewed before an inspection report is submitted for review and before it is finalized. The Error Check section will display the items in SIIMS that do not meet current QC or formatting guidelines. Each error must be corrected before the inspection report can be finalized. Some errors may be corrected automatically when the SNBI calculations are manually recalculated.

Some common errors are:

- Field(s) left blank in the Load Rating Evaluation Form
- Comment field left blank when a condition rating is 5 or less
- SI&A (SNBI) data not completed

2.1.1.1 Typical Bridge Inspection Report Sections

A typical bridge inspection report must consist of the sections indicated below in the following order:

1. Cover
2. Table of Contents
3. Executive Summary
4. SI&A (SNBI)
5. Deck
6. Superstructure
7. Substructure
8. Channel (if channel is present)
9. Elements
10. Pictures
11. Sketches
12. Load Rating (if a new load rating was performed)
13. Maintenance Recommendations (if recommendations exist)
14. Program Recommendations (if recommendations exist)
15. Map

2.1.1.2 Typical Culvert Inspection Report Sections

A typical culvert inspection report must consist of the sections indicated below in the following order:

1. Cover
2. Table of Contents
3. Executive Summary

4. SI&A (SNBI)
5. Culvert
6. Channel
7. Elements
8. Pictures
9. Sketches
10. Load Rating (if a new load rating was performed)
11. Maintenance Recommendations (if recommendations exist)
12. Program Recommendations (if recommendations exist)
13. Map

2.1.1.3 "Print" Check Box

The "Print" check box must be checked for all the required sections of an inspection report for the section to be included in the PDF file. Several of the additional sections not required for a typical inspection report, must not be deleted from the report listing. The "Print" check box must be left unchecked, so these sections do not appear in the final inspection report but are available to view or print at a later date. These sections include:

- SNBI - Channel - State
- Critical Finding
- Load Rating Evaluation
- SNBI - Supplementary Inspection Information
- SNBI – Features
- SNBI – Routes
- SNBI – Special Inspection

The final inspection report does not require printing or saving. The report can be viewed, printed, or e-mailed any time after the report is finalized. For all sections included in the final report, the box under the columns "Include in Table of Contents" and "Show Page Number" must be checked.

Documents created outside of SIIMS can be added to an inspection report. If a document is not one of the standard documents in SIIMS but would be a valuable item to include in a report, it can be added from the Report Sections window.

2.5.13 Inspection Information

The Inspection Information section in SIIMS includes information related to what, when, and how an inspection was completed. The date of the inspection(s) type performed is updated in this section. The inspection frequency can be updated as needed for any of the inspection types. The Primary Inspector's name and anyone who assisted in the inspection are to be listed in the appropriate fields.

If an inspection was performed later than the required frequency due to unforeseen or unusual circumstances, an explanation of the "Unusual Circumstances" for exceeding the inspection frequency is required in the field provided. This will inform FHWA as to why an inspection could not be completed as scheduled.

A general comments field is provided in this section for inspectors to provide information to the Program Manager or other inspectors about special issues related to the given bridge. This information is not included in any report section and is for internal use only.

2.6 SNBI DATA

The Specifications for the National Bridge Inventory (SNBI) is a compilation of all SNBI data submitted annually to FHWA. Iowa's SNBI form does not contain all fields submitted to FHWA, as the SNBI format is not in a single standard form required by FHWA. Each state is able to format the form in any way it chooses. Iowa DOT's format was developed to provide as much information as possible in an organized way.

The SI&A form in SIIMS contains information pulled from other SIIMS forms or external databases as well as data that must be entered directly on the SI&A form. Most of this information must be entered within 90 days of the bridge being opened to traffic. The fields on the SI&A form are defined as shown in FHWA's Specifications for the National Bridge Inventory.

For bridges on the State and federal highway system, if errors are found in fields on the SI&A form that are not editable by the bridge inspector, BSB must be contacted to have the errors corrected.

2.7 FEATURES ON AND UNDER A BRIDGE

The Features section in SIIMS pertains to all SNBI Features on and under a bridge. The inventory Feature(s) under a bridge consists of all pathways or channels that are under the bridge. The data for these must be manually coded or verified each inspection using guidance provided by the SNBI. The following fields, can be edited by the bridge inspector in the Features form using a separate column for each unique Feature:

2.7.1 Features

1. Item B.F.01.1 Feature Type Selection
2. Item B.F.01 Feature Type
3. Item B.F.02 Feature Location
4. Item B.F.03 Feature Name

2.7.2 Highways

1. B.H.01 Functional Classification
2. B.H.02 Urban code
3. B.H.03 NHS Designation
4. B.H.04 National Highway Freight Network
5. B.H.05 STRAHNET Designation
6. B.H.06 LRS Route ID
7. B.H.07 LRS Mile Point
8. B.H.08 Lanes on Highway
9. B.H.09 Annual Average Daily Traffic (ADT)
10. B.H.10 Annual Average Daily Truck Traffic (ADTT)
11. B.H.11 Year of Annual Average Daily Traffic
12. B.H.12 Highway Maximum Usable Vertical Clearance
13. B.H.13 Highway Minimum Vertical Clearance

14. B.H.14 Highway Minimum Horizontal Clearance, Left
15. B.H.15 Highway Minimum Horizontal Clearance, Right
16. B.H.16 Highway Maximum Usable Surface Width
17. B.H.17 Bypass Detour Length
18. B.H.18 Crossing Bridge Number

2.7.3 Railroads

1. B.RR.01 Railroad Service Type
2. B.RR.02 Railroad Minimum Vertical Clearance
3. B.RR.03 Railroad Minimum Horizontal Offset

2.7.4 Navigable Waterways

1. B.N.01 Navigable Waterway
2. B.N.02 Navigation Minimum Vertical Clearance
3. B.N.03 Movable Bridge Max Navigation Vert Clearance
4. B.N.04 Navigation Channel Width
5. B.N.05 Navigation Channel Min Horizontal Clearance
6. B.N.06 Substructure Navigation Protection

A bridge will have multiple Features if more than one signed route goes under the bridge. Each route must have a separate Feature. All items listed above will have to be populated for each inventory route, railroad, and waterway Feature passing under the bridge.